Radiological Health Data

VOLUME III, NUMBER 2

FEBRUARY 1962

Monthly Report

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Except where material is directly quoted or otherwise credited, summaries and abstracts are prepared by the Radiological Health Data and Reports Staff, Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
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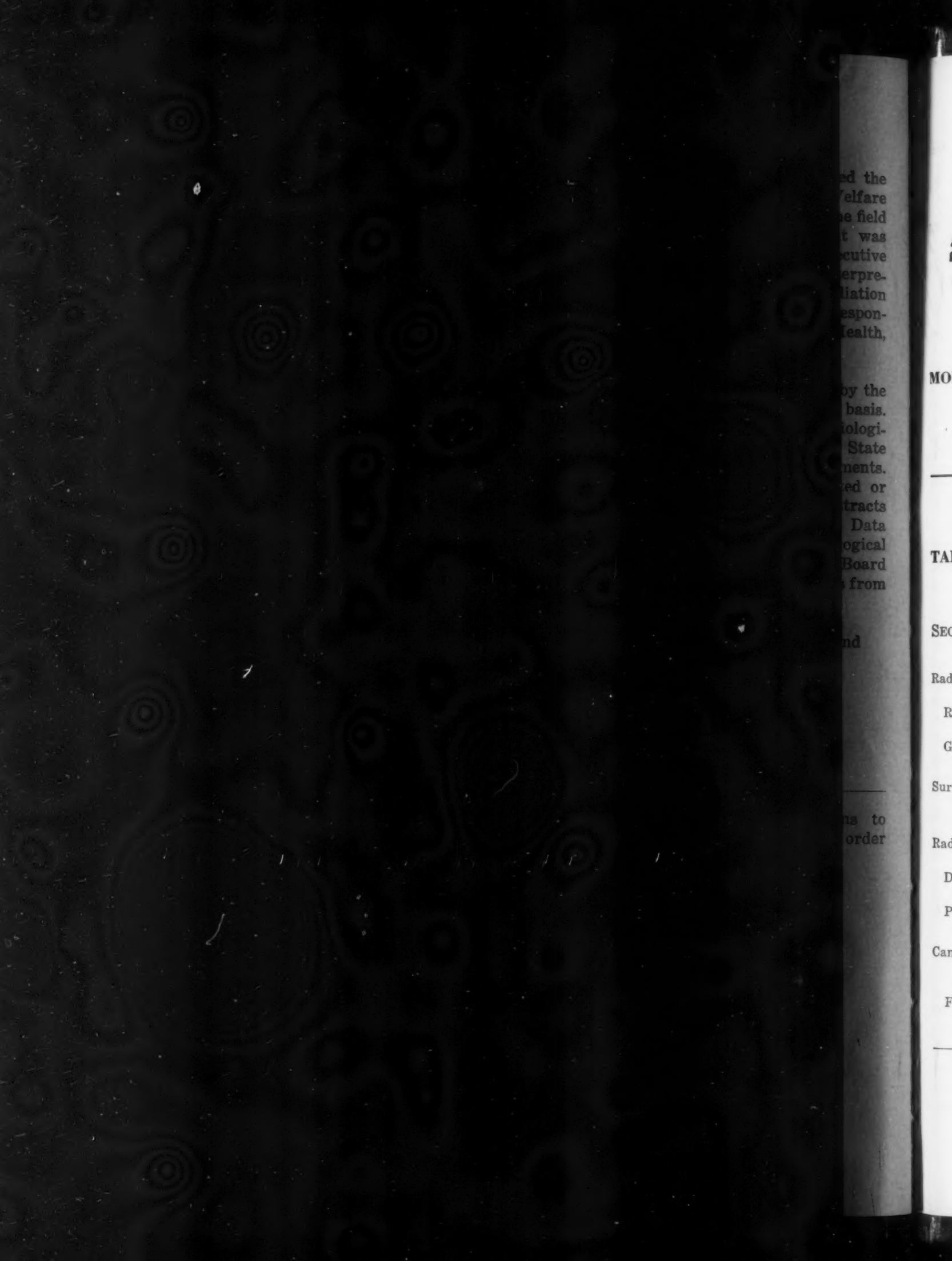

RADIOLOGICAL HEALTH DATA

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Radiation Surveillance Network

Division of Radiological Health, Public Health Service

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in levels of radioactivity in air and precipitation due to fallout from nuclear weapons tests. Prior to September 1961, it consisted of 45 stations at urban locations operated by State and local health department personnel with 2 of the stations operated by Public Health Service personnel. Following the resumption of nuclear weapons testing in September 1961, the network has been expanded to 62 stations (see figure 1).

Measurements of gross beta radioactivity in air at ground level are taken because they provide one of the earliest and most sensitive indications of increases of activity in the environment and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone.

Air is drawn through a cellulose carbon-loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. Field measurements with a portable survey meter enable the operator to estimate the amount of beta activity of particulates in air at the station five hours after collection by comparison with a known radioactive source. The filters are then forwarded to the central laboratory of the Radiation Surveillance Network in Washington, D.C., for a more refined measurement using a thin-window proportional counter.

Table 1 presents the monthly summary report of fission product gross beta concentrations in surface air during November 1961. Table 2 presents the first publication in *Radiological Health Data* of the Radiation Surveillance Network data for gross beta radioactivity of precipitation. Before the resumption of nuclear weapons testing, the values were generally below the levels of accurate determination by present instrumentation.

One continuous precipitation sample is taken for each air sampling period, using locally-made collector funnels having collecting areas of approximately 0.4 square meter. One-half liter of the collected precipitation is evaporated to dryness, and the residue is forwarded to the Laboratory and counted by the same method used for analyzing the air samples. The results in table 2 are the summation of the daily results for the month indicated, expressed in micromicrocuries per square meter ($\mu\mu c/m^2$). To determine the average concentration, divide the $\mu\mu c/m^2$ by the amount of rainfall in millimeters. When a "less than" value occurs in the daily results, one-half of the number is used for the monthly summation.

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR, GROSS BETA DETERMINATIONS, NOVEMBER 1961

Station location		Number samples	Maximum ($\mu\mu c/m^3$)	Minimum ($\mu\mu c/m^3$)	Average[1] ($\mu\mu c/m^3$)	Station location		Number samples	Maximum ($\mu\mu c/m^3$)	Minimum ($\mu\mu c/m^3$)	Average[1] ($\mu\mu c/m^3$)
City	State					City	State				
Adak	Alaska	21	5.6	0.10	3.3	Minneapolis	Minn.	30	35	1.3	7.1
Anchorage	Alaska	30	17	0.76	8.0	Jackson	Miss.	29	32	2.3	8.4
Attu	Alaska	20	9.2	<0.10	4.9	Pascagoula	Miss.	17	27	0.62	12
Cold Bay	Alaska	30	9.3	<0.10	4.4	Jefferson City	Mo.	30	30	0.85	6.8
Fairbanks	Alaska	30	6.8	0.50	3.8	Helena	Mont.	30	65	3.4	12
Juneau	Alaska	30	17	0.26	5.6	Lincoln	Nebr	22	44	1.1	12
Kodiak	Alaska	30	13	0.73	5.0	Trenton	New Jersey	30	18	2.2	7.0
Nome	Alaska	29	22	0.35	4.9	Santa Fe	N. Mex.	30	39	2.3	12
Point Barrow	Alaska	29	9.4	1.5	3.9	Albany	N. Y.	30	47	1.3	8.4
St. Paul Island	Alaska	22	10	0.47	4.0	New York	N. Y.	7	24	3.8	13
Phoenix	Ariz.	30	27	2.3	11	Gastonia	N. C.	30	35	0.77	9.5
Little Rock	Ark.	30	23	0.85	8.0	Bismarck	N. Dak.	29	40	1.6	6.6
Berkeley	Calif.	30	35	0.93	14	Columbus	Ohio	29	48	2.2	9.5
Los Angeles	Calif.	30	61	4.4	17	Oklahoma City	Okla	30	18	0.44	7.9
Denver	Colo.	30	49	1.8	12	Ponca City	Okla.	28	10	0.20	4.1
Hartford	Conn.	30	43	0.79	11	Portland	Oreg.	30	36	2.0	11
Washington	D. C.	30	37	4.1	12	Harrisburg	Pa.	30	25	2.8	7.0
Jacksonville	Fla.	28	32	4.6	12	San Juan	P. R.	25	9.6	0.16	3.1
Miami	Fla.	28	44	1.9	11	Providence	R. I.	30	40	0.75	8.3
Atlanta	Ga.	29	25	1.2	8.1	Columbia	S. C.	27	28	0.82	8.3
Agana	Guam	21	5.3	0.11	1.9	Pierre	S. Dak.	29	57	1.5	10
Honolulu	Hawaii	30	20	<0.10	5.1	Nashville	Tenn.	28	30	1.1	9.8
Boise	Idaho	30	50	3.0	18	Austin	Tex.	30	29	0.20	9.4
Springfield	Ill.	29	47	0.84	9.1	El Paso	Tex.	30	30	1.9	10
Indianapolis	Ind.	30	23	2.1	7.5	Salt Lake City	Utah	30	30	2.2	10
Iowa City	Iowa	30	18	0.78	5.8	Richmond	Va.	30	33	1.7	8.3
Topeka	Kans.	30	15	1.2	6.7	Seattle	Wash.	30	19	0.91	6.1
Frankfort	Ky.	26	20	1.6	8.0	Madison	Wis.	29	20	0.76	7.6
New Orleans	La.	30	33	1.0	10	Cheyenne	Wyo.	30	28	1.3	10
Baltimore	Md.	30	23	2.7	9.0	Sundance	Wyo.	4	20	7.8	11
Lawrence	Mass.	29	15	0.29	5.5						
Lansing	Mich.	30	40	2.9	11	Network average					8.5

[1] Weighted average obtained by summing the products of individual sampling times and the corresponding activities, and dividing by the summation of the individual sampling times.

TABLE 2.—GROSS BETA RADIOACTIVITY IN PRECIPITATION, SEPTEMBER 1961

Station location		Rainfall (millimeters)	Deposition ($\mu\mu c/m^2$)	Station location		Rainfall (millimeters)	Deposition ($\mu\mu c/m^2$)
City	State			City	State		
Anchorage	Alaska	118.1	192,280	Helena	Montana	29.3	51,990
Fairbanks	Alaska	47.9	53,570	Las Vegas	Nevada	—	—
Juneau	Alaska	214.2	92,310	Trenton	New Jersey	—	—
Phoenix	Arizona	*—	—	Santa Fe	New Mexico	26.5	4,180
Little Rock	Arkansas	109.5	33,440	Albany	New York	39.0	10,240
Berkeley	California	9.6	1,680	New York	New York	—	—
Los Angeles	California	1.5	1,190	Gastonia	North Carolina	<0.1	260
Denver	Colorado	58.3	93,470	Bismarck	North Dakota	—	—
Hartford	Connecticut	40.7	8,070	Columbus	Ohio	—	—
Washington	District of Columbia	15.6	6,230	Oklahoma City	Oklahoma	51.8	21,730
Jacksonville	Florida	13.4	6,330	Ponca City	Oklahoma	123.5	145,420
Miami	Florida	—	—	Portland	Oregon	14.8	13,750
Atlanta	Georgia	16.1	3,200	Harrisburg	Pennsylvania	12.4	4,560
Honolulu	Hawaii	25.5	5,650	San Juan	Puerto Rico	—	—
Boise	Idaho	29.9	13,080	Providence	Rhode Island	75.2	15,100
Springfield	Illinois	127.5	42,770	Columbia	South Carolina	80.0	29,000
Indianapolis	Indiana	85.1	14,890	Pierre	South Dakota	40.1	28,250
Iowa City	Iowa	187.9	36,930	Nashville	Tennessee	—	—
Frankfort	Kentucky	—	—	Austin	Texas	103.2	18,150
Topeka	Kansas	118.0	126,500	El Paso	Texas	23.6	5,300
New Orleans	Louisiana	119.3	29,330	Salt Lake City	Utah	28.0	15,700
Baltimore	Maryland	—	—	Richmond	Virginia	26.0	38,280
Lawrence	Massachusetts	40.4	6,500	Seattle	Washington	16.5	14,230
Lansing	Michigan	35.0	8,680	Spokane	Washington	—	—
Minneapolis	Minnesota	40.0	14,560	Madison	Wisconsin	151.4	50,450
Pascagoula	Mississippi	33.0	41,250	Cheyenne	Wyoming	55.4	71,930
Jefferson City	Missouri	135.6	23,710				

*Dash denotes no sample received.

Surface Air Radon, Thoron, and Fission Product Gross Beta Concentrations at Cincinnati, Ohio

Robert A. Taft Sanitary Engineering Center, Public Health Service

The determination of natural background radiation in our atmosphere is useful because the exposure levels from natural radiation can be used as a base for comparative evaluations of exposures from artificially produced radionuclides. Natural radioactivity in surface air is attributed to a number of unstable nuclides other than those produced by man. The earth's crust contains trace amounts of uranium and thorium that occur naturally and which decay through a series of their daughter products. These decay products of uranium and thorium are introduced into surface air through their rare gas daughters, radon (radon-222) and thoron (radon-220), which in turn continue to decay through the uranium and thorium series, respectively. The radon and thoron content of air depends on the escape of these rare radioactive gases from the earth. Concentrations depend on prevailing conditions such as ambient temperature, humidity, and pressure, and on soil conditions such as moisture, porosity, and temperature.

Most of the natural radioactivity in surface air is due to radon (Rn^{222}) and its daughters. Thoron (Rn^{220}) and its daughters contribute much less because of thoron's short half-life and hence, a lower diffusion rate from the soil.

Radiological Health Research Activities, Research Branch, Division of Radiological Health, Public Health Service, performs a continuous daily sampling program for radon (Rn^{222}), thoron (Rn^{220}), and gross beta fission product concentrations in surface air at Cincinnati. The gross beta activity of atmospheric particulates, when measured several days after sample collection, is principally due to artificially produced radionuclides.

Radon-222 concentrations are determined from alpha measurements made immediately after the sampling period (24 to 72 hours) has ceased. Radon-222 (a.m.) concentrations have been corrected for any radon-220 daughter interferences. Radon-222 (p.m.) concentrations are derived from alpha measurements made in the afternoon (3 p.m.) approximately 7 hours after the new sampling period has begun. These values are from the same filters that are counted at 8 a.m. the following day. Radon-222 (p.m.) concentrations are uncor-

rected for any radon-220 daughter interferences. Radon-220 concentrations are determined from alpha measurements made on the sample used to evaluate the corrected radon-222 (a.m.) concentrations, but are counted 7 hours after the sampling period has ceased. Reported values are corrected to the time of removal of the filter.

The data are now computed by an electronic data processing system which is programmed for thirteen four-week periods per calendar year. The data for the period October 9-November 3, 1961, appears in table 1.

REFERENCE

Setter, L. R. and G. I. Coats "The Determination of Airborne Radioactivity," *American Industrial Hygiene Association Journal, 22,* No. 1, Feb. 1961.

TABLE 1.—SURFACE AIR RADON (Rn^{222}), THORON (Rn^{220}), AND FISSION PRODUCT GROSS BETA CONCENTRATIONS AT CINCINNATI, OHIO, OCTOBER 9–NOVEMBER 3, 1961

End of sampling period		Continuous sample collection			Rn^{222} 8 a.m. ($\mu\mu c/m^3$)	Rn^{222}[a] 3 p.m. ($\mu\mu c/m^3$)	Rn^{220} ($\mu\mu c/m^3$)	Beta activity ($\mu\mu c/m^3$)
		Sample change time	Sample period (hours)	Volume (m^3)				
October	9	0800	71.9	86.7	1090	200	12.1	7.23
	10	0802	24.0	28.7	1530	250	12.4	5.49
	11	0803	24.0	28.8	710	240	4.9	6.41
	12	0802	24.0	29.0	1170	220	8.7	5.53
	13	0801	23.9	28.7	1340	250	4.9	5.55
	16	0805	72.0	87.5	850	210	6.9	3.05
	17	0805	23.9	28.8	1450	200	5.8	3.51
	18	0800	23.8	28.0	1110	130	9.0	3.93
	19	0803	24.0	27.7	820	120	8.7	5.04
	20	0805	24.0	27.7	160	230	1.9	1.09
	23	0810	72.0	80.7	1060	400	9.2	3.41
	24	0801	23.8	27.1	1770	550	3.1	9.34
	25	0810	24.1	27.7	650	250	8.4	5.23
	26	0818	24.1	27.8	180	130	2.1	5.25
	27	0805	23.7	28.3	820	190	8.9	2.75
	30	0810	72.0	85.4	270	170	5.6	11.54
	31	0800	23.8	28.9	170	120	1.7	2.86
November	1	0814	24.2	29.7	820	280	3.7	2.17
	2	0807	23.8	29.3	390	100	3.6	3.42
	3	0813	24.1	29.7	100	30	0.1	1.88
Average					819	221	6.7	5.1
Range of counting errors (2σ)								
Maximum					76	40	1.2	0.2
Minimum					20	10	0.1	0.1

[a] Sample period and volume does not apply to this column.

Radioactivity Measurements In Surface Air

U.S. Naval Research Laboratory

Radioactivity measurements of air-filter samples collected at various sites near the 80th Meridian (West) are made by the U.S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during September 1961 is presented in table 1, and the radioactivity profile for the same month and the third quarter of 1961 are shown in figure 2. This figure illustrates the data plotted in semilogarithmic coordinates. Due to the increased levels of radioactivity, another cycle has been added to the figure. The abscissa is expressed in micromicrocuries per cubic meter of surface air. The concentrations in table 1 are expressed in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

FIGURE 1.—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

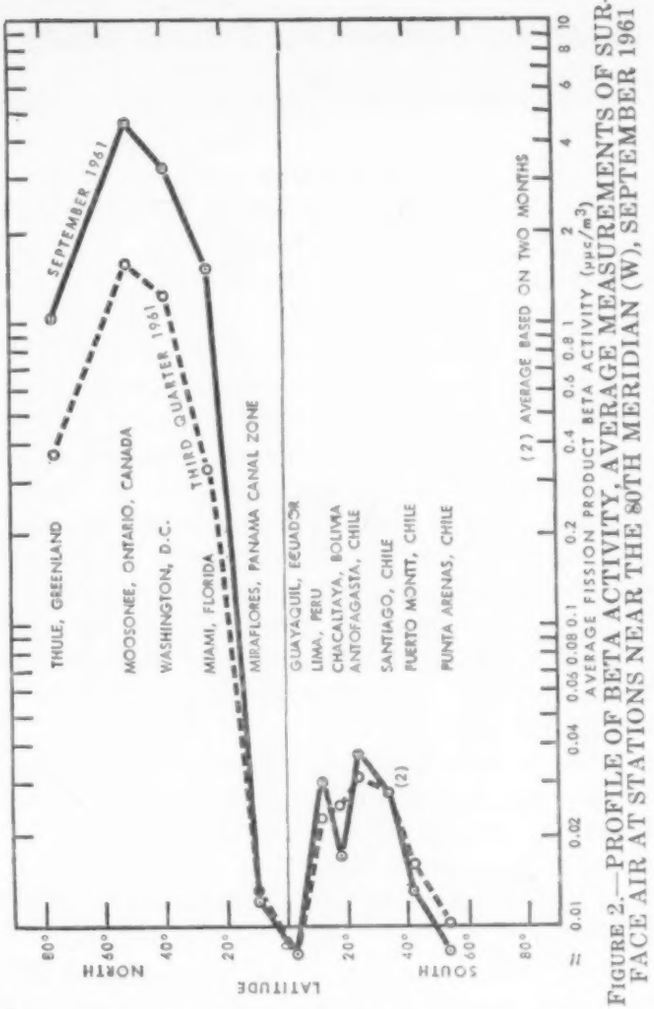


FIGURE 2.—PROFILE OF BETA ACTIVITY, AVERAGE MEASUREMENTS OF SURFACE AIR AT STATIONS NEAR THE 80TH MERIDIAN (W), SEPTEMBER 1961

TABLE 1.—DAILY RECORD OF FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, SEPTEMBER 1961

[Disintegrations/minute per cubic meter]

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil Ecuador	Miraflores, Panama Canal Zone	Mauna Loa, Hawaii	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule, Greenland
1	<0.01	0.03	0.03	0.12	0.04	0.07	0.02	0.03	0.06	0.07	0.10	0.06	0.03
2	<0.01	0.02	0.03	0.12	0.04	0.07	0.02	0.03	0.06	0.07	0.10	0.06	0.03
3	<0.01	0.02	0.03	0.12	0.04	0.07	0.02	0.03	0.06	0.07	0.10	0.06	0.03
4	<0.01	0.02	0.03	0.12	0.04	0.07	0.02	0.03	0.06	0.07	0.10	0.06	0.03
5	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.05	0.06
6	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.05	0.06
7	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.05	0.06
8	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.05	0.06
9	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.15	0.06
10	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.12	0.06
11	0.02	0.03	0.09	0.05	0.02	0.06	<0.01	0.01	0.20	0.07	0.09	0.19	0.06
12	0.02	0.03	0.05	0.10	0.04	0.04	<0.01	0.02	1.49	0.63	8.97	0.16	1.73
13	0.02	0.03	0.05	0.10	0.04	0.04	0.02	0.02	1.49	0.63	8.97	0.11	1.73
14	0.02	0.03	0.05	0.10	0.04	0.04	0.02	0.02	1.49	0.63	8.97	0.44	1.73
15	0.02	0.03	0.05	0.10	0.04	0.04	0.02	0.02	1.49	0.63	8.97	0.28	1.73
16	0.02	0.03	0.05	0.10	0.04	0.04	0.02	0.02	1.49	0.63	8.97	0.91	1.73
17	0.02	0.03	0.05	0.10	0.04	0.04	0.02	0.02	1.49	0.63	8.97	17.80	1.73
18	0.02	0.03	0.05	0.10	0.04	0.04	0.02	0.02	1.49	0.63	8.97	17.80	1.73
19	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	21.02	1.47
20	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	21.02	1.47
21	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	71.67	1.47
22	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	47.10	1.47
23	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	0.76	1.47
24	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	24.65	1.47
25	0.02	0.03	0.05	0.09	0.05	0.11	0.02	0.03	0.70	9.52	16.40	31.99	1.47
26	0.02	----------	0.08	0.06	0.04	0.05	0.02	0.05	0.37	5.86	11.41	8.95	9.31
27	0.02	----------	0.08	0.06	0.04	0.05	0.02	0.05	0.37	5.86	11.11	13.48	9.31
28	0.02	----------	0.08	0.06	0.04	0.05	0.02	0.05	0.37	5.86	11.41	----------	9.31
29	0.02	----------	0.08	0.06	0.04	0.05	0.02	0.05	0.37	5.86	11.41	----------	9.31
30	0.02	----------	0.08	0.06	0.04	0.05	0.02	0.05	0.37	5.86	11.41	----------	9.31
Mean (dpm/m³)	0.018	0.029	0.062	0.082	0.038	0.067	0.017	0.026	0.627	3.371	7.846	10.334	2.316
Mean (μμc/m³)	0.008	0.013	0.028	0.037	0.017	0.030	0.008	0.012	0.282	1.518	3.534	4.655	1.043

Canadian Radioactive Fallout Study Program

Department of National Health and Welfare, Ottawa, Canada

As part of its radioactive fallout study program, the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada, conducts air and precipitation sampling programs.

The nationwide air sampling program is conducted for two main purposes: (1) to provide a convenient method for the early detection of changes in the fission product concentration in the air and therefore of likely changes in the deposition products on the ground, and (2) to obtain data to show the day-to-day and station-to-station variations. This may be useful to meteorologists for obtaining a better understanding of the mechanisms involved in radioactive fallout distribution in the atmosphere.

A more detailed discussion of the sampling procedures, methods of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report Number CNHW (RP-3).

With the permission of the Department of National Health and Welfare, Dominion of Canada, *Radiological Health Data* published data on fission product gross beta activity in air and precipitation in Volume II, Numbers 1, 4, 8, and 12 covering the periods July 1959-June 1960, the third and fourth quarters 1960, and the first quarter 1961 respectively. In addition, daily measurements of gross beta radioactivity in air were presented for the period September 4 through October 15, 1961. Second quarter 1961 data are reported in tables 1, 2, and 3. Daily measurements of gross beta radioactivity for the latter part of October are presented in table 4. These data show continued higher levels, as noted earlier in October, which reflect increases due to the resumption of atmospheric nuclear weapons testing; however, the more recent daily data do not appear to be increasing. Unless a significant increase is observed, daily measurements will not be reported in future issues.

FIGURE 1.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS

Overall monthly average levels of gross beta radioactivity in air in table 2 for the second quarter of 1961 are generally higher than those

TABLE 1.—FISSION PRODUCT GROSS BETA RADIOACTIVITY IN AIR, SECOND QUARTER 1961

[Average concentration in $\mu\mu c/m^3$]

Station location	April	May	June
Calgary	0.17	0.23	0.26
Chatham	0.12	0.19	0.23
Coral Harbour	0.15	0.16	0.10
Edmonton	0.15	0.23	0.24
Fort Churchill	0.09	0.14	0.10
Fort William	0.14	0.22	0.24
Fredericton	0.10	0.15	0.19
Goose Bay	0.13	0.15	0.15
Inuvik	0.18	0.15	0.10
Kapuskasing	0.15	0.24	0.23
Montreal	0.10	0.19	0.25
Moosonee	0.14	0.20	0.16
Ottawa	0.12	0.17	0.20
Regina	0.17	0.27	0.29
Resolute	0.09	[a] NS	0.06
Saskatoon	0.17	0.24	0.25
Shearwater	0.09	0.17	0.16
Torbay	0.13	0.15	0.20
Toronto	0.14	0.21	0.24
Vancouver	0.12	0.17	0.16
Whitehorse	0.13	0.22	0.11
Windsor	0.17	0.27	0.26
Winnipeg	0.16	0.27	0.29
Yellowknife	0.18	0.21	0.23

[a] NS—No sample.

TABLE 2.—MONTHLY AVERAGE FISSION PRODUCT GROSS BETA CONCENTRATIONS IN AIR, SECOND QUARTER 1961

[Radioactivity in $\mu\mu c/m^3$]

Month	Number of stations operating 50% of the time	Minimum average all stations	Maximum average all stations	Overall average
April	23	0.09	0.18	0.14
May	23	0.14	0.27	0.20
June	24	0.06	0.29	0.20

of the first quarter, but appear to be constant during May and June. This is the usual pattern observed at this time of year.

The overall monthly average levels of precipitation in table 3 appear to be slightly higher than for the previous quarter. This is again consistent with the rises usually observed at this time of the year.

TABLE 3.—FISSION PRODUCT GROSS BETA RADIOACTIVITY IN PRECIPITATION, SECOND QUARTER 1961

Station location	April		May		June	
	Millimeters	μμc/liter	Millimeters	μμc/liter	Millimeters	μμc/liter
Calgary	37.8	42.5	42.7	66.9	9.9	15.2
Chatham	136.9	25.8	134.1	28.9	73.9	30.4
Coral Harbour	13.5	35.0	15.5	73.0	13.2	171.7
Edmonton	22.9	44.1	24.6	100.3	46.7	74.5
Fredericton	94.7	28.9	164.8	28.9	82.8	25.9
Fort Churchill	82.8	25.8	21.8	56.2	36.3	56.3
Fort William	39.6	30.4	59.2	51.7	35.1	80.5
Goose Bay	23.1	34.9	131.6	24.3	78.0	45.6
Inuvik	49.5	6.1	64.3	19.8	24.4	24.3
Kapuskasing	25.1	47.2	109.5	39.5	78.7	28.9
Montreal	106.9	9.1	62.5	21.3	146.6	10.6
Moosonee	16.3	50.2	[a] NS	—	69.1	88.2
Ottawa	100.6	24.3	86.6	30.4	92.7	38.0
Regina	13.7	69.9	57.2	68.4	13.7	142.9
Resolute	[a] NS	—	NS	—	NS	—
Saskatoon	27.7	42.6	61.0	69.9	43.9	126.2
Shearwater	127.8	22.8	141.0	13.7	70.1	27.4
Torbay	120.4	27.4	91.7	18.2	36.8	15.2
Toronto	105.7	22.8	71.1	33.4	128.5	31.9
Vancouver	48.0	53.2	98.0	39.5	25.9	79.0
Whitehorse	16.3	66.9	4.8	320.7	88.1	30.4
Windsor	153.4	30.4	66.8	104.9	73.2	41.1
Winnipeg	43.2	69.9	9.9	124.6	3.3	256.8
Yellowknife	10.7	13.6	1.3	547.2	53.3	21.2
Average	—	35.8	—	85.5	—	63.6

[a] NS—No sample.

TABLE 4.—DAILY RECORD OF FISSION PRODUCT GROSS BETA RADIOACTIVITY IN AIR, OCTOBER 16 TO OCTOBER 31, 1961

[Concentrations in μμc/m³]

Station location	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Calgary	43.6	36.9	25.6	5.8	4.8	4.4	16.6	11.2	12.8	27.0	81.0	42.3	42.3	67.5	4.5	9.9
Chatham, N. B	8.8	7.1	10.8	22.3	5.0	5.0	15.1	13.1	18.0	18.0	1.8	4.4	3.7	11.2	22.0	15.3
Edmonton	72.0	72.9	14.2	21.6	1.8	2.5	3.6	26.1	12.8	18.0	27.9	24.3	17.1	45.0	12.4	6.8
Fort Churchill	7.2	4.3	2.1	6.6	10.1	26.1	7.5	3.2	6.1	10.4	8.3	10.0	12.6	6.5	6.8	24.8
Fort William	21.6	10.4	7.0	5.7	7.5	18.0	18.0	18.4	27.4	30.2	9.0	3.1	11.2	26.1	15.1	60.8
Fredericton	8.1	10.4	24.3	12.7	8.2	12.2	10.8	14.0	10.4	2.2	5.2	5.6	16.2	23.4	23.0	27.9
Goose Bay	3.6	8.8	6.2	5.9	11.2	10.8	4.3	23.2	23.4	20.2	13.3	7.0	7.7	3.3	0.6	0.4
Inuvik	5.0	3.5	1.9	1.9	10.1	[a]—	—	5.7	7.8	13.2	7.3	16.2	1.1	2.5	6.0	2.5
Kapuskasing	2.4	14.0	14.0	4.4	16.6	16.6	10.8	26.1	23.4	25.6	15.8	14.4	11.7	8.3	5.3	—
Montreal	23.4	30.6	10.0	23.3	11.2	8.1	16.6	20.7	14.0	13.5	16.6	7.1	19.4	37.4	43.9	24.3
Moosonee	15.7	15.7	6.7	—	11.2	10.2	22.6	21.6	27.0	23.0	17.1	4.3	3.6	7.2	19.2	—
Ottawa	23.8	18.0	32.4	21.4	14.4	18.0	33.8	21.6	20.2	17.1	13.0	6.9	14.4	42.8	36.0	32.0
Regina	4.3	20.9	9.0	16.8	19.4	8.8	8.6	21.6	21.2	11.0	7.0	13.5	25.6	11.2	20.5	36.4
Saskatoon	34.2	12.1	12.1	8.1	3.2	1.1	10.4	26.1	13.5	6.8	11.7	13.5	9.0	85.5	27.0	21.6
Shearwater	16.0	11.3	24.8	15.8	4.5	13.7	14.2	17.6	4.4	0.1	7.4	17.2	18.9	29.3	18.0	32.1
Torbay	8.6	24.5	30.2	—	18.2	8.3	18.0	18.9	18.9	20.7	5.3	0.7	17.1	6.8	14.4	11.7
Toronto	16.0	14.0	19.1	29.7	14.8	17.3	25.4	31.1	36.4	24.3	18.4	8.1	9.4	40.5	47.2	22.0
Vancouver	13.3	10.4	—	16.6	5.9	4.4	6.8	5.0	7.2	36.0	9.9	13.5	3.1	—	7.1	—
Whitehorse	9.1	6.6	12.2	17.1	11.0	21.4	9.0	4.5	15.3	4.3	7.6	4.4	6.8	16.6	17.6	6.3
Windsor	19.4	35.6	23.0	—	6.5	16.6	27.9	49.5	24.3	12.6	15.3	7.4	27.0	58.5	32.0	13.7
Winnipeg	3.4	14.4	3.8	7.9	14.2	18.9	14.9	35.1	15.8	12.2	9.4	15.8	19.4	13.0	83.2	10.3
Yellowknife	4.5	3.2	0.8	4.2	7.9	15.0	6.9	3.7	7.6	47.2	7.4	7.2	4.1	5.4	8.3	6.5
Average	16.6	17.5	13.8	13.1	9.9	12.2	14.4	19.0	16.7	17.9	14.4	11.2	13.7	26.1	21.0	19.2

[a] Dash denotes no sample.

SECTION II. — FOOD OTHER THAN MILK

Radiation Intelligence Network

Division of Radiological Health, Public Health Service

The March 1961 *Radiological Health Data* discussed the Radiation Intelligence Network and outlined two total diet sampling programs that were in progress. The following is a report on the Institutional Diet Sampling Program which studies the dietary intake of the critical younger age group, specifically, persons under 18.

INSTITUTIONAL DIET SAMPLING PROGRAM

Criteria for Pilot Study

In outlining the initial surveillance plan for the estimate of radiation exposure levels resulting from the ingestion of radioactivity in the total diet, the following basic criteria were established for the locations where sampling operations were to be carried out.

a. Composite diet at point of consumption. Preliminary studies of data available concerning food consumption habits in the United States indicated that the pilot study should not be based on market survey information as it appeared that these data were not precise enough to furnish the necessary information on the radioactivity intake. Estimates based on available information of the variation in eating habits, as well as consideration of the minimum quantities of food required for radioassay, resulted in the selection of a minimum composite diet sample of 21 consecutive meals including snacks or other dietary intake to be assayed each month.

b. Controlled population in specific age group. Initial sampling was concentrated on a young age group, specifically persons under 18, due to the relative importance of radiation exposure for this population group. The conclusion was soon reached that the "boarding school," or similar institution for children, offered the best opportunity for sampling in the initial phases of the study. Since stability was considered an important population characteristic, the relative permanence of membership within such institutions was thought to present the best opportunity for investigation of potential relationships or associations between food intake, radiation exposure, and the demographic characteristics of a group for study during a period of months to years.

c. Geographic spread. Because of the expected regional variation in food consumption patterns, the broadest possible geographic representation was included in the selection of sampling points. The assumption was made that the pattern of food consumption at each selected institution would generally reflect the pattern extent for the geographical region. No attempt was made to set standards of economic

condition for the institution selected, in fact, in selecting the sampling points some effort was made to pick institutions with some variation in this characteristic.

d. On-site food service. An additional requirement imposed for the selection of institutions for diet sample collection was that an on-site food service be in operation, providing three complete meals each day to the population group under study. Those institutions using government surplus food were generally avoided as the prolonged storage of such food might produce results atypical of the area under study.

Field Sampling Operations

The current institutional diet sampling program in operation consists of 13 boarding schools or institutions scattered throughout the United States. They represent young people between the ages of 5 and 18 and range from exclusive and expensive boarding schools to orphanages with severe economic limitations. Initially, seven sampling points were set up as pilot stations to perfect sample collection, transportation, and routine laboratory assay techniques. Each location is supported by a regular Pasteurized Milk Monitoring Program sampling station and by regular municipal water supply analytical data. This sampling program will be increased to at least 20 institutions during 1962. The following 13 locations are being sampled as of December 1961:

Atlanta, Georgia
Austin, Texas
Boston, Massachusetts
Chicago, Illinois
Denver, Colorado
Helena, Montana
Honolulu, Hawaii
Los Angeles, California
Memphis, Tennessee
New York, New York
Palmer, Alaska
Salt Lake City, Utah
Seattle, Washington
St. Louis, Missouri
Tampa, Florida

In general, the sampling procedure is the same in each case. Each sample, as it reaches the laboratory, represents a full seven-day week diet of 21 meals plus soft drinks, candy bars, or other in-between snacks obtained by duplicating the meals of a different individual each day. Each institution supplies one total 7-day diet sample each month.

Upon completion of the sampling procedure, the frozen sample is placed in the shipping carton together with an adequate supply of dry ice and shipment by air-express to either the Southwestern or Southeastern Radiological Health Laboratory at Las Vegas, Nevada, or Montgomery, Alabama, respectively. Each sample usually consists of 6 to 16 liters, weighing between 8 to 20 kilograms.

Analytical Program for Food Sample

The basic analytical program for the Institutional Diet Sampling Program was designed around three basic procedures: (1) gamma scan, (2) strontium-90 analysis, and (3) total radium analysis. In the absence of interference, other than naturally-occurring radioactive potassium (K^{40}), minimum detectable levels on a per kilogram basis are 10, 5, 450 and 15 μμc for iodine-121, cesium-137, potassium-40 and zinc-65 respectively. Gamma scan results for composite food samples obtained before and after the nuclear weapons test moratorium have shown marked differences. The principal activity observed prior to the resumption of testing is that of potassium-40, though earlier samples contained small amounts of cesium-137, while iodine-131 and other fission product radionuclides appeared after September 1961.

Total weight, ash and moisture determination and stable calcium and potassium are obtained by conventional gravimetric or spectrophotometric methods. Values for potassium-40 intake range from 440 to 3,800 μμc per day with an average of 2,300 μμc per day. Phosphate determinations are by colorimetric technique. Calcium or phosphorous compounds may have an effect on the uptake of important bone seeking radionuclides such as strontium-89 and 90. Hence, these determinations were included in the analytical program. Total radium is determined by ashing, separation, and coprecipitation of radium and barium sulphate or chromate. After transfer to planchets, alpha

activity is determined by an internal proportional counter with appropriate delay for check of ingrowth of radium daughters. As soon as emanation equipment is installed and calibrated, a specific determination for radium-226 will be made. The total radium technique is a practical screening indicator, but other natural radionuclides may contribute to the reported total radium values and hence, the bone dose calculated by assuming radium-226 is correspondingly but conservatively high.

Summary of Results

1. The dietary intake of strontium-90 by young people for all sampling points was estimated by this program to range from 1.3 to 14.6 μμc/day from food, beverages, and snacks served in boarding schools at several locations in this country. This value lies within the lowest radiation protection guidance limit of the Federal Radiation Council of 0 to 20 μμc/day for strontium-90.

2. The dietary intake of total radium by the children studied was estimated to be 1.7 to 12.7 μμc/day with an average intake of 5.9 μμc/day. Assuming the radium-226 component of the total radium activity is at least 30 percent, the intake of radium-226 via the diet lies near the upper limit of the Range I level of the radiation protection guidance of the Federal Radiation Council (of 0 to 2 μμc per day for radium-226).

3. The rapid scanning of composite diet samples by means of crystal detectors and gamma spectrometry is a useful method of establishing limits of possible contamination of food by gamma emitting radionuclides. A 3½ liter volume, or the solid equivalent, of the sample is counted. It is important to count fairly large amounts of low-level samples in order to measure as much total activity as possible. Using this technique, the minimum levels of detection, on a per kilogram basis, are: 10, 5, 450, and 15 μμc for iodine-131, cesium-137, potassium-40, and zinc-65, respectively. The weights of 3½ liters of composite food samples may vary from 6 to 8 percent, depending primarily upon the amount of moisture contained in a given sample. The reported absence then, of identifiable peaks in the gamma scan, reflects the absence of the above radionuclides at the level indicated.

4. Though attempts were made to document the diet items by menu as served at the sampling point, the variation in radioactivity content due to strontium-90 and radium could not be attributed to the presence of any specific diet item. Comparison of the total diet intake levels of strontium-90 with those previously reported for milk confirms previous estimates that milk may account for approximately one-half of the dietary intake of this radionuclide.

5. Preliminary results of tests made at two sampling stations for iodine-131 since resumption of nuclear weapons testing, show that the principal contributor of this radionuclide to the dietary intake of children is fresh milk. Iodine-131, as indicated by the milk sampling program has been absent during the last two years of the weapons test moratorium. This has been the case for strontium-89 and barium-lanthanum-140, with only the long half-life cesium-137 and strontinum-90 evidence in milk.

Discussion

The Institutional Diet Sampling Program is directed to determining both technical and administrative feasibility of estimating ranges of radiation exposure resulting from the ingestion of radioactivity in the diet. As a preliminary pilot study, this has been demonstrated successfully, subject to the limitations imposed by sampling techniques. It must be assumed that the samples obtained actually are representative of the average dietary intake for the institution. This latter factor is now the subject of careful investigation and study. It is not believed at this time that the type of surveillance which will be developed from this study for routine purposes will be adequate to initiate control measures or countermeasures that might become necessary as a result of increased fallout levels. It is believed that such studies must be carried out in more detail at the State and local levels. Studies on these problems are concurrently being conducted by the Public Health Service in cooperation with the State and local health authorities under the guidance of the National Advisory Committee on Radiation to the Surgeon General.

Tables 1 and 2 present the results for January through August 1961.

TABLE 1.—INSTITUTIONAL DIET SAMPLING—SEVEN-DAY COMPOSITE SAMPLES, 1961

Location	Data	January	February	March	April	May	June	July	August	Daily average
Los Angeles, California	Wt. (Kg)[1]		10.8	18.1	12.0	12.0	11.9	5.4		1.7
	Moisture (Kg)				9.2	9.2	8.9	4.0		1.1
	Ash (gm)		94	114	100	100	52	49		12.1
	Ca (gm)		4.54	5.61	6.96	6.96	16.5			1.2
	Ra (μμc)		18	42	36	36	27	41		4.8
	Sr 90 (μμc)		38	23	28	28	<26	29		4.0
Denver, Colorado	Wt. (Kg)	7.2	12.8	14.6	11.8	20.8		9.7	18.7	2.0
	Moisture (Kg)					15.6		7.3	14.9	1.8
	Ash (gm)	62	123	168	123	198		61	166	18.4
	Ca (gm)	3.82	6.14	10.51	7.55	12.9		10.28	12.5	1.3
	Ra (μμc)	16	12	88	47	48		54	84	7.1
	Sr 90 (μμc)	24	74	17	21	58		15	34	5.0
Atlanta, Georgia	Wt. (Kg)			12.1	13.0	11.1	9.4	11.8	11.7	1.6
	Moisture (Kg)						6.9	9.3	9.1	1.2
	Ash (gm)			129	134	119	123	98	65	15.9
	Ca (gm)			7.0	8.3	6.3	9.2	5.80	3.9	0.96
	Ra (μμc)			21	[2] <20	28	<55	50	<26	4.8
	Sr 90 (μμc)			66	61	49	64	50	33	7.7
St. Louis, Missouri	Wt. (Kg)	12.4	16.1	13.2	16.0	11.9		22.5	18.5	2.2
	Moisture (Kg)					9.5		17.6	14.1	2.0
	Ash (gm)	104	159	149	176	91		204	212	22.3
	Ca (gm)	5.1	6.9	8.4	9.8	5.7		11.2	12.2	1.4
	Ra (μμc)	42	51	54	70	33		72	89	8.4
	Sr 90 (μμc)	93	92	29	53	42		<102	63	9.7
New York City, New York	Wt. (Kg)	10.6	8.4	7.6	5.6	10.1	11.4	4.3	9.1	1.2
	Moisture (Kg)					7.2	8.6	2.6	6.4	0.9
	Ash (gm)	105	72	79	75	108	100	47	105	12.3
	Ca (gm)	2.4	4.2	3.3	1.8	5.1	6.9	1.9	8.4	0.61
	Ra (μμc)	<20	<20	<20	<16	20	<25	<20	<42	3.3
	Sr 90 (μμc)	48	19	35	20	35	39	9	65	4.8
Austin, Texas	Wt. (Kg)		16.9	17.1	17.3	14.7	17.3	16.8	18.2	2.4
	Moisture (Kg)					10.8	12.4	12.5	13.3	1.8
	Ash (gm)		152	185	165	153	186	164	177	24.1
	Ca (gm)		8.8	10.1	10.6	9.0	11.2	9.8	11.0	1.43
	Ra (μμc)		<32	<25	<25	<50	<70	<70	<70	7.0
	Sr 90 (μμc)		61	73	73	65	35	98	87	10.0
Seattle, Washington	Wt. (Kg)		15.5	18.4	16.9	15.1	17.0	13.8	16.1	2.3
	Moisture (Kg)					11.6	13.2	10.9	13.2	1.7
	Ash (gm)		147	138	169	153	148	134	150	21.2
	Ca (gm)		6.8	8.6	7.9	8.0	14.1	8.9	9.2	1.3
	Ra (μμc)		26	15	46	23	83	59	42	6.0
	Sr 90 (μμc)		88	40	69	23	58	13	56	7.1

[1] Total weight of original seven-day sample.
[2] Radium and strontium-90 values shown at the detection limit are included in the averages as detection limit values.

TABLE 2.—DAILY INTAKE OF RADIUM AND STRONTIUM-90 VIA THE TOTAL DIET OF CHILDREN UNDER 18[1]

[Concentrations in μμc/day]

Location	No. of weekly samples	Strontium-90			Radium		
		High	Low	Average	High	Low	Average
California	6	5.4	3.3	4.0	6	2.6	4.8
Colorado	7	10.6	2.2	5.0	12.6	1.7	7.1
Georgia	6	9.4	4.7	7.7	7.9	2.9	4.8
Missouri	7	14.6	4.1	9.7	12.7	4.7	8.4
New York	8	9.3	1.3	4.8	6.0	2.3	3.3
Texas	7	14.0	5.0	10.0	10.0	2.1	7.0
Washington	7	12.6	2.0	7.1	11.9	2.1	6.0
All stations	48	14.6	1.3	6.9	12.7	1.7	5.9

[1] Computed from measured Sr-90 and radium content of weekly composite samples, exclusive of drinking water but including all beverages and snacks. Samples collected at boarding schools for children at locations shown between January 1931 and August 1961.

SECTION III. — MILK

Milk Monitoring Program

Division of Radiological Health, Public Health Service

Milk monitoring has been conducted by the Public Health Service since early 1957, when the first program was established to develop suitable sampling methods and radiochemical analytical proficiencies. Raw milk was initially selected for investigation. During this program, it became evident that a broader sampling program was necessary—one more directly related to the milk consumed by the population. The result was the initiation, in the first quarter of 1960, of a pasteurized milk sampling program designed to provide data representative of the milk consumed in selected municipalities. Both programs were operated concurrently until June 1961 to permit comparison of the differences between the earlier, limited, milkshed sampling results and those of the new program.

Raw milk sampling results reported for June 1961 in the November 1961 *Radiological Health Data* were the last regular publication of such data. A summary discussion of the raw milk sampling program in the December 1961 *Radiological Health Data* presented the gross relationship between fallout and the occurrence of fission products in milk determined from this study.

Surveillance of pasteurized milk is currently conducted at 60 stations (shown in figure 1) with the cooperation of State and local milk sanitation agencies, who ship samples to the PHS Southeastern and Southwestern Radiological Health Laboratories for analysis. The former analyzes samples from the 30 states generally east of the Mississippi River, and the latter analyzes samples from the western states. Publication of data follows about four months after sample collection because of time required for shipment, processing, decay-product build-up, data compilation, and publication procedures.

The current program emphasizes (1) measurement of the levels of radioactivity of samples of pasteurized milk consumed by the public in various regions of the country, and (2) provision of at least one sampling point within most states and additional points when indicated by widely varying conditions of the milk supply or the need to cover large population groups. Each sample is composited in proportion to the volume of milk sold by those plants supplying not less than 90 percent of a city's milk supply. Prior to September 15, this composite sample was taken from one day's sales per month and was as representative of a community's total supply as could be achieved under practical conditions. Since September 15, the sampling schedule has been accelerated.

Normally, assays for strontium-89, strontium-90, iodine-131, cesium-137, barium-140, and stable calcium are performed on the one sample obtained at each sampling location dur-

ing the month. The regular September pasteurized milk samples in most cases were obtained during the first 15 days of the month, before any effect of Russian atmospheric nuclear weapons testing was observed. Prior to this time, the values for strontium-89, barium-140, and iodine-131 were below the level of detection by current instrumentation. The lower level of detection for strontium-89 is 5 μμc/liter, and for barium-140 and iodine-131, 10 μμc/liter.

During the second week in September, when increased levels of gross beta radioactivity in air were observed by the Radiation Surveillance Network, the frequency of milk sampling was accelerated at selected stations. Daily sampling of pasteurized milk, with analyses for iodine-131 content, was initiated on September 19 at six selected stations.

Iodine-131, cesium-137, and barium-140 are determined by gamma scintillation spectroscopy, while strontium-89 and strontium-90 are determined following radiochemical separation. The cesium-137 and barium-140 data were determined on most of the milk samples obtained for iodine-131 analyses by the Southwestern Radiological Health Laboratory.

Because the normal monthly milk sample was taken during the first half of September when the levels were representative of those that have existed for the past year and more samples were obtained during the last half of September, special treatment of the data was necessary. To determine the average for the month of September, the value for the one sample taken in the first 15 days was weighted the same as the average value of all the samples taken during the last half of the month. When a radionuclide was not detectable, one-half of the nondetectable value was used for averaging. If no additional samples were obtained for a station when the level was nondetectable during the first 15 days of September, a dash appears in the table, indicating that no fully representative average for the month or quarter could be determined.

Table 1 presents a summary of all available analyses. The numbers in parentheses indicate the number of samples involved in each average, and are a guide to the reliability of the

FIGURE 1.—PASTEURIZED MILK AREA SAMPLING STATIONS

TABLE 1.—RADIOACTIVITY IN MILK—PASTEURIZED MILK AREA SAMPLING STATIONS, SEPTEMBER 1961

[Radioactivity concentrations in $\mu\mu c$/liter]

Area		Calcium (gm/liter)			Strontium-89		Strontium-90			Iodine-131		Cesium-137			Barium-140	
City	State	Second quarter	Third quarter	September[a]	Third quarter	September[a]	Second quarter	Third quarter	September[a]	Third quarter	September[a]	Second quarter	Third quarter	September[a]	Third quarter	September[a]
Palmer	Alaska	1.03	1.12	1.10	[b] —	—	9	7	7	—	—	5	10	20	—	—
Phoenix	Ariz.	0.97	1.04	1.06	—	—	5	4	4	—	—	5	<5	5	—	—
Little Rock	Ark	1.21	1.21	1.22	—	—	19	16	16	—	—	25	10	10	—	—
Sacramento	Calif	1.05	1.10	1.25 (2)	<5	<5 (2)	5	5	6 (2)	<10	10 (3)	<5	10	15 (3)	<10	<10 (3)
San Francisco	Calif	1.04	1.06	1.06	—	—	5	4	4	—	—	10	10	15	—	—
Denver	Colo.	1.01	1.05	1.07 (2)	<5	5 (2)	6	5	5 (2)	20	60 (4)	5	10	15 (4)	<10	10 (4)
Hartford	Conn.	1.17	1.15	1.15	—	—	9	8	7	—	—	30	15	10	—	—
Wilmington	Del.	1.20	1.18	1.16	—	—	10	10	9	—	—	15	15	<5	—	—
Washington	D. C.	1.18	1.14	1.18 (2)	5	10 (2)	8	7	7 (2)	20	40 (5)	20	10	<5	<10	<10 (2)
Tampa	Fla.	1.23	1.24	1.26 (3)	<5	<5 (3)	6	5	5 (3)	20	40 (7)	110	85	100 (4)	<10	<10 (3)
Atlanta	Ga.	1.29	1.23	1.20 (4)	<5	5 (4)	10	10	9 (4)	30	80 (8)	20	15	15 (5)	<10	<10 (4)
Honolulu	Hawaii	0.96	1.06	1.14	—	—	4	6	7	—	—	10	10	5	—	—
Idaho Falls	Idaho	1.04	1.05	1.04	—	—	5	6	3	—	—	10	5	5	—	—
Chicago	Ill.	1.17	1.14	1.15 (2)	10	20 (2)	8	5	5 (2)	40	110 (2)	10	15	10 (2)	<10	<10 (2)
Indianapolis	Ind.	1.23	1.18	1.18	—	—	8	6	6	—	—	10	10	<5	—	—
Des Moines	Iowa	1.01	1.04	1.02	—	—	7	7	7	—	—	5	10	10	—	—
Witchita	Kans.	1.01	1.08	1.00	—	—	8	11	13	—	—	10	5	10	—	—
Louisville	Ky.	1.18	1.15	1.18	—	—	11	9	11	—	—	10	5	<5	—	—
New Orleans	La.	1.30	1.28	1.27 (3)	5	10 (3)	13	13	13 (3)	30	90 (10)	20	25	25 (4)	<10	10 (3)
Portland	Maine	1.26	1.19	1.20 (2)	10	20 (2)	10	9	7 (2)	10	20 (2)	40	30	20 (2)	<10	<10 (2)
Baltimore	Md.	1.23	1.16	1.20	—	—	8	10	8	—	—	15	15	10	—	—
Boston	Mass.	1.21	1.17	1.16	—	—	11	10	9	—	—	35	30	20	—	—
Detroit	Mich.	1.17	1.14	1.16	—	—	8	6	6	—	—	15	5	<5	—	—
Grand Rapids	Mich.	1.25	1.18	1.18	—	—	7	7	9	—	—	15	5	<5	—	—
Minneapolis	Minn.	1.07	1.07	1.06	—	—	7	9	5	—	—	10	15	10	—	—
Jackson	Miss.	1.35	1.26	1.30 (3)	5	10 (3)	14	12	13 (3)	50	150 (8)	15	15	20	<10	<10 (3)
Pascagoula	Miss.	[c] NA	NA	NA	NA	NA	NA	NA	NA	70	200 (2)	NA	NA	NA	NA	NA
Kansas City	Mo.	1.08	1.04	1.05	—	—	12	9	7	—	—	15	5	5	—	—
St. Louis	Mo.	1.09	1.07	1.09 (3)	10	30 (3)	8	8	10 (3)	60	180 (11)	20	10	15 (11)	<10	10 (11)
Helena	Mont.	1.02	1.05	1.02	—	—	6	7	10	—	—	10	15	25	—	—
Omaha	Nebr	1.07	1.13	1.04	—	—	6	8	6	—	—	10	10	15	—	—
Manchester	N. H.	1.23	1.19	1.19	—	—	12	9	8	—	—	45	40	20	—	—
Trenton	N. J.	1.17	1.14	1.14	—	—	9	8	8	—	—	15	10	<5	—	—
Albuquerque	N. Mex.	1.06	1.09	1.06	—	—	5	3	3	—	—	5	5	10	—	—
Buffalo	N. Y.	1.22	1.13	1.10	—	—	8	7	7	—	—	15	10	10	—	—
New York	N. Y.	1.17	1.13	1.16 (2)	5	10 (2)	9	9	10 (2)	50	140 (3)	25	15	15	10	20 (2)
Syracuse	N. Y.	1.19	1.15	1.15	—	—	7	6	6	—	—	15	10	10	—	—
Charlotte	N. C.	1.26	1.22	1.19	—	—	12	12	11	—	—	15	10	10	—	—
Minot	N. Dak.	—	1.04	1.04	5 (1)	15 (1)	—	7 (1)	7 (1)	20 (2)	30 (2)	—	10 (1)	10 (1)	10 (1)	<10 (1)
Cincinnati	Ohio	1.24	1.20	1.17	—	—	9	9	10	—	—	10	<5	<5	—	—
Cleveland	Ohio	1.20	1.17	1.16	—	—	8	7	8	—	—	10	5	10	—	—
Oklahoma City	Okla.	1.22	1.19	1.20	—	—	8	6	6	—	—	5	5	10	—	—
Portland	Oreg.	1.05	1.10	1.14	—	—	12	11	8	—	—	30	20	25	—	—
Philadelphia	Pa.	1.18	1.18	1.18	—	—	9	8	6	—	—	15	15	10	—	—
Pittsburgh	Pa.	1.27	1.15	1.16	—	—	12	11	10	—	—	20	10	<5	—	—
San Juan	P. R.	1.23	1.17	1.18	—	—	4	4	5	—	—	5	10	15	—	—
Providence	R. I.	1.17	1.15	1.15	—	—	10	12	10	—	—	40	30	20	—	—
Charleston	S. C.	1.25	1.22	1.23 (3)	<5	5 (3)	12	11	12 (3)	30	90 (6)	25	30	35 (5)	<10	<10 (3)
Chattanooga	Tenn.	1.33	1.28	1.30	—	—	11	12	12	—	—	15	15	10	—	—
Memphis	Tenn.	1.30	1.23	1.20	—	—	13	12	14	—	—	10	5	5	—	—
Austin	Tex.	1.24	1.20	1.17	<5	<5 (3)	3	2	3 (3)	10	20 (4)	5	<5	<5 (2)	<10	<10 (3)
Dallas	Tex.	1.24	1.17	1.18	<5	5 (2)	9	6	5 (2)	10	20 (2)	10	10	10 (2)	<10	<10 (2)
Salt Lake City	Utah	1.01	1.16	1.19 (2)	5	10 (2)	5	4	5 (2)	50	140 (2)	10	10	15 (2)	<10	<10 (2)
Burlington	Vt.	1.22	1.14	1.08	—	—	8	8	6	—	—	15	15	15	—	—
Norfolk	Va.	1.26	1.22	1.24	—	—	9	9	10	—	—	20	10	<5	—	—
Seattle	Wash.	1.03	1.06	1.09 (2)	10	25 (2)	9	11	11 (2)	<10	10 (2)	25	15	15 (2)	<10	<10 (2)
Spokane	Wash.	1.02	1.04	1.04	—	—	8	9	6	—	—	15	20	20	—	—
Charleston	W. Va.	1.20	1.17	1.19	—	—	9	11	12	—	—	15	10	<5	—	—
Milwaukee	Wis.	1.19	1.17	1.19	—	—	6	5	5	—	—	20	10	<5	—	—
Laramie	Wyo.	1.00	1.04	1.04	—	—	5	7	7	—	—	10	15	20	—	—

[a] Numbers in parentheses indicate total number of analyses reported during September. The regular monthly sample, taken during the first two weeks of September (before the effect of the Russian atmospheric nuclear weapons testing), is weighted for 15 days and the average of those analyses reported during the last two weeks is also weighted for 15 days to obtain the September average.

Absence of parentheses indicates that one sample was taken prior to the effect of the Russian testing in the atmosphere during September.

[b] Dash indicates that the concentration was reported to be less than the level of detection. The sample was collected prior to the effect of Russian testing.

[c] NA indicates no analyses reported.

average for the month. Some of the strontium-89 and strontium-90 data are based on weekly composites of daily samples taken near the end of September.

The sampling schedule in effect during most of October 1961 was presented in the January 1962 *Radiological Health Data*. With the conclusion of the Soviet Union's 1961 series of atmospheric tests, the iodine-131 levels are more predictable and it becomes necessary for the analytical program to shift to other radionuclides. This need is emphasized by the fact that the analytical procedures become more difficult as the levels of activity become lower and the longer lived nuclides increase in relative importance. Therefore, beginning in December 1961, the following sampling schedule became effective:

1. Six daily sampling stations (St. Louis, Seattle, New York, Chicago, Boston, and New

Orleans) to be maintained so that the pattern of normal decline in iodine-131 content of milk at these points may be carefully studied.

2. Any station in the program, not included in the daily sampling schedule where the iodine-131 level exceeds 100 μμc/liter at the time of sampling, to be placed on a two samples per week schedule until this level drops and remains below 100 for two consecutive weeks.

3. All other sampling stations to be placed on a weekly sampling schedule.

4. A full analysis to be completed on a weekly basis for all samples (stable calcium and potassium, strontium-89, strontium-90, zinc-65, cesium-137, barium-140 and iodine-131). For those stations where samples are collected more often than once a week, the laboratories will composite for the weekly analytical schedule as above, except for those radionuclides immediately determined by gamma scan on each sample as received.

All surveillance data will be subject to continuing review and evaluation to observe unusual patterns or levels which may require immediate attention and adjustment in the pasteurized milk sampling program operation. Further atmospheric nuclear testing would, of course, require an immediate reevaluation and readjustment of the sampling frequency and analytical schedule for this program.

Comparison of the results of the September averages with the second and third quarter averages shows that the September stable calcium, strontium-90, and cesium-137 results are generally within anticipated variations. The limited number of analyses for strontium-89 and barium-140 show only that these nuclides are beginning to appear in pasteurized milk. The iodine-131 levels have shown an increase and the daily results for September were published in *Radiological Health Data*, Volume II, Number 11.

Strontium-90 in Canadian Dried Milk Products

Department of National Health and Welfare, Ottawa, Canada

The following table presents the results of measurements of strontium-90 in Canadian dried milk for the months of April, May, and June, 1961. This table was included in the "Quarterly Report of the Radioactive Fallout Study Program," dated October 1961, published by the Radiation Protection Division of the Department of National Health and Welfare, Ottawa, Canada. Figure 1 shows the sampling locations. The samples were collected by inspectors of the Marketing Division of the Department of Agriculture.

Data for the year of 1960 were published in *Radiological Health Data*, Volume I, Numbers 6 and 9, and Volume II, Numbers 4, 8, and 12.

TABLE 1.—STRONTIUM-90 CONTENT OF CANADIAN DRIED MILK POWDER SAMPLES

[Concentrations in μμc/gm calcium]

Station	Type of milk	April 1961	May 1961	June 1961
Calgary	skim	8.3	9.4	5.8
Charlottetown	skim	[2] NS	NS	NS
Chicoutimi	skim	13.8	12.6	NS
E. Florenceville	skim	13.1	15.2	11.7
Edmonton	skim	9.0	11.0	5.5
Granby	skim	13.3	14.2	11.2
Halifax[1]	skim	7.2	9.1	8.9
La Durantye	skim	9.9	12.7	15.6
London	skim	4.6	3.8	3.6
Megantic	skim	15.0	14.6	14.3
Moncton	buttermilk	8.5	9.5	10.7
Ottawa	skim	4.8	5.8	3.7
Saskatoon	buttermilk	7.0	8.2	5.6
Sussex	skim	10.7	13.5	13.1
Vancouver	skim	10.1	10.8	12.2
Walkerton	skim	4.7	4.9	4.0
Winnipeg	buttermilk	5.6	6.4	4.7
Average		8.8	9.8	8.4

[1] New Station. Natural strontium concentration not yet determined. A factor of 1.06 was used for correction of the sample. The results of all other stations were corrected for natural strontium in the sample. This determination was made by neutron activation at A.E.C.L. Chalk River.
[2] NS = No milk powder manufactured for the month.

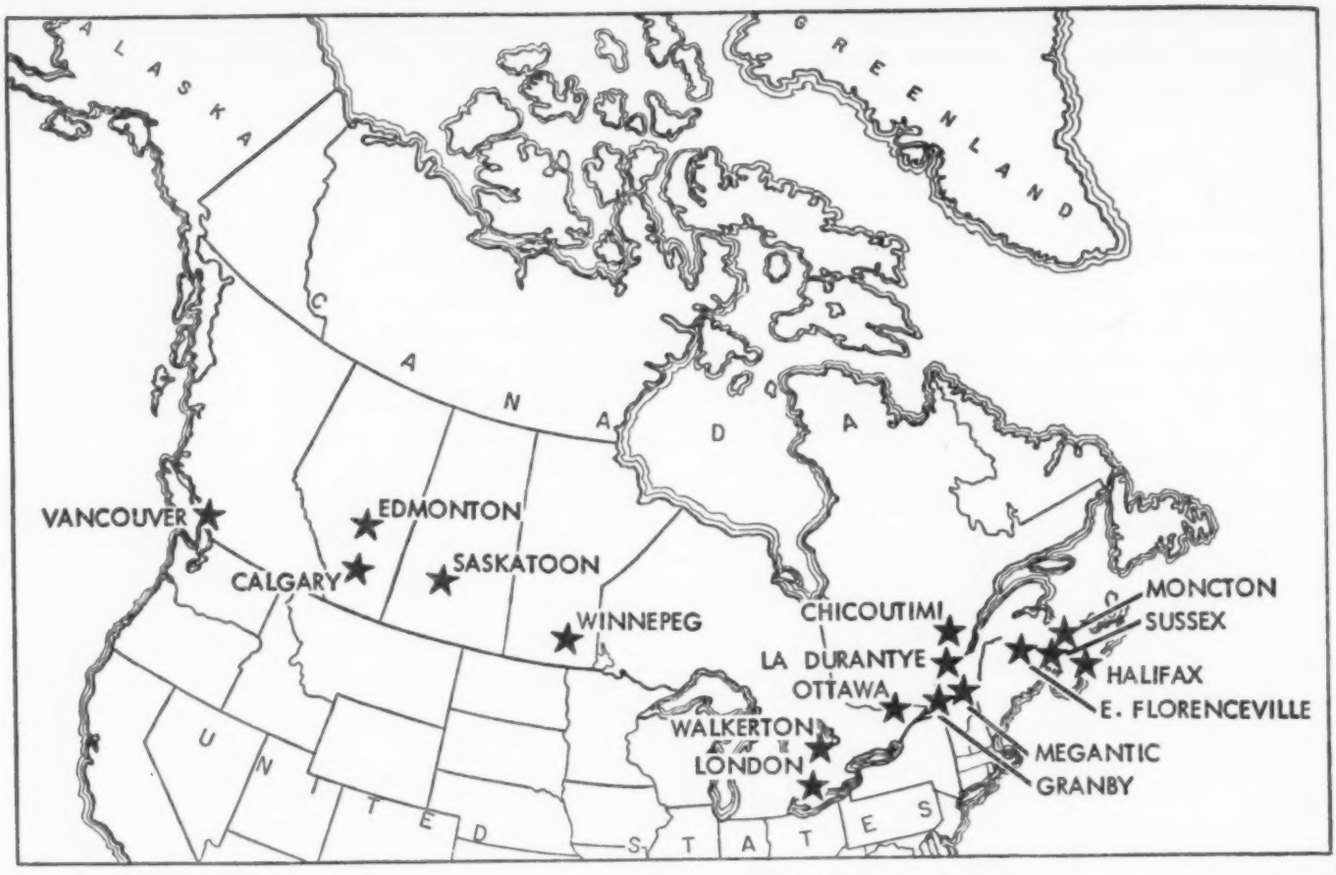


FIGURE 1.—MILK SAMPLING STATIONS IN CANADA

SECTION IV. — WATER

National Water Quality Network

Division of Water Supply and Pollution Control, Public Health Service

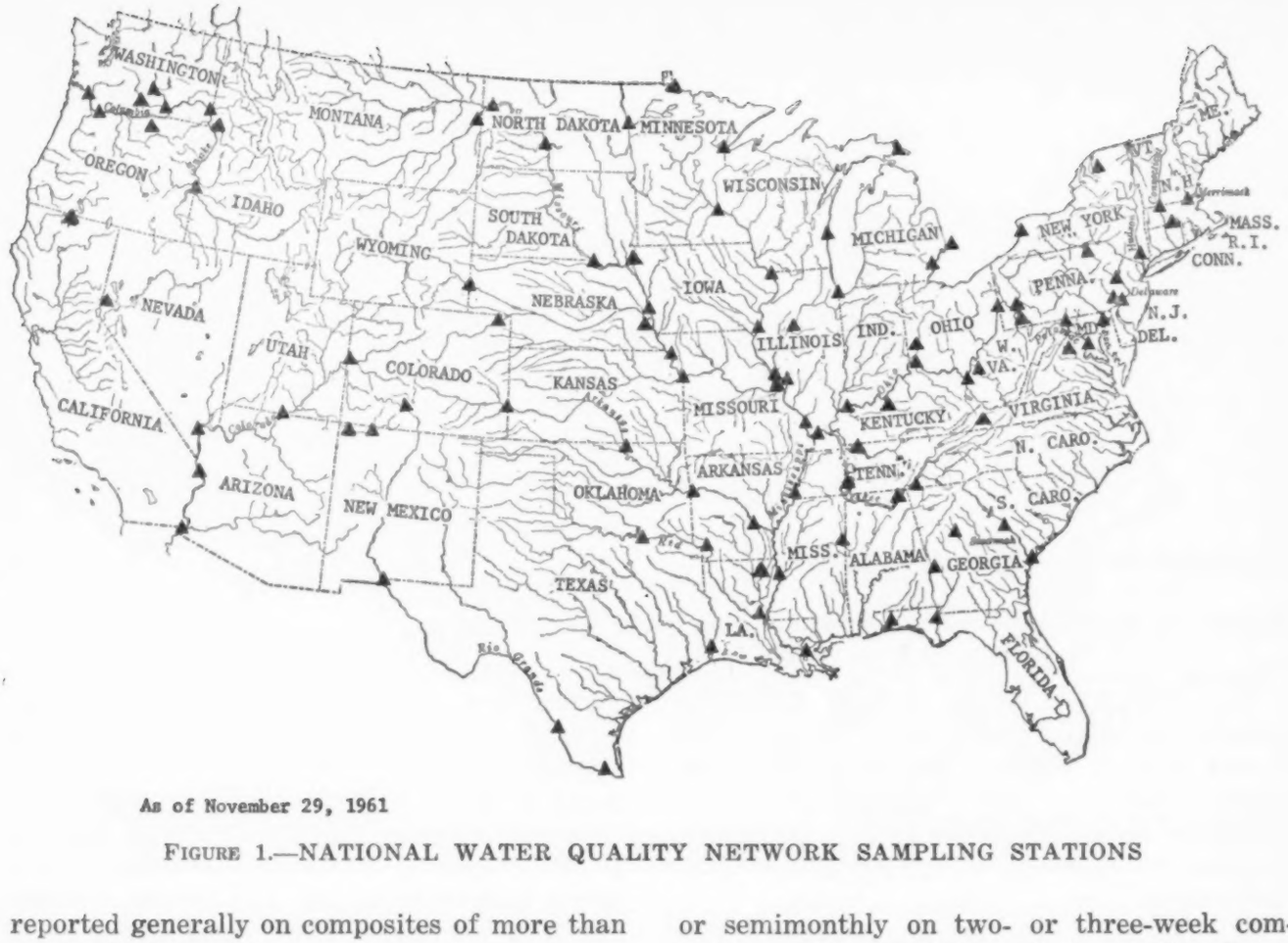
The National Water Quality Network operates under the provision of Section 4 (c) of the Federal Water Pollution Control Act, which states ". . . The Secretary shall . . . collect and disseminate basic data . . . (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and Local agencies, and industrial organizations commenced operations in October 1957. As of December 1, 1961, there were 97 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial, and other uses. Some of these stations are on interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately, a total of approximately 300 stations will be in operation. Radioactivity is not yet being reported for a few of the more recently established stations.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some, continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in raw surface water samples. The levels of radioactivity associated with dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally-occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing for a period of three years, the beta activity in most raw waters generally had approached a level attributable solely to natural sources. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. The resumption of nuclear weapons testing in the atmosphere by the USSR has resulted in an increase in radioactivity of surface waters. Preliminary evidence obtained during October 1961 indicates a 5- to 10-fold increase in gross beta radioactivity of the surface waters over the 1960 average in some areas, particularly in North Central, Northeastern, and Eastern United States. The greater percentage of increase in the radioactivity is in the suspended solids.

For the first two years of the Network operations, beta determinations were made on weekly samples, Alpha determinations were



As of November 29, 1961

FIGURE 1.—NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS

reported generally on composites of more than one weekly sample.

Beginning January 1, 1960, the frequency of beta determinations varied depending on the status of each particular station. For the first operating year of each new station, analyses were being conducted weekly. Weekly analyses were to be continued indefinitely from all stations which may be affected by waste discharges from nuclear installations. Semimonthly determinations (on composites of 2 or 3 weekly samples) were conducted for stations which still showed some beta activity above background. Monthly determinations (on composites of all samples received from a station during the month) were conducted on samples from streams where beta activity was at background levels.

Beginning January 1, 1960, the frequency of alpha determinations also was changed. For the first operating year of each new station, analyses were to be done weekly. At some stations on the Colorado and Animas Rivers determinations were done on weekly samples or semimonthly on two- or three-week composites. The remainder of the stations were scheduled so that each had one gross alpha determination per month.

The following changes were instituted on September 1, 1961, after the resumption of nuclear weapons testing:

1. Gross beta counts are to be made on all samples collected. (Compositing weekly samples for monthly or semimonthly gross alpha and beta counting will cease).
2. Beginning with samples collected October 1, 1961, strontium-90 determinations are to be made on a three months composite of weekly samples.

Gross alpha counts are to be made on one sample for each station each month, unless there is evidence of alpha activity. In the latter instance, an alpha determination will be made on a weekly or bi-weekly basis depending on what is considered the norm for a particular station.

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Concentrations in μμc/liter]

Station	Quarter ending June 30, 1961	July 1961					
		Beta activity			Alpha activity		
	Strontium-90	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	0.2	2	6	8	0	<1	<1
Animas River: Cedar Hill, N. Mex	[a]—	4	17	21	1	8	9
Arkansas River:							
Coolidge, Kansas	—	141	4	145	22	16	38
Ponca City, Okla	0.7	—	—	—	—	—	—
Big Sioux River: Sioux Falls, S. Dak	—	6	27	33	1	1	2
Chattahoochie River:							
Atlanta, Ga	0.3	2	1	3	1	0	[illegible]1
Columbus, Ga	—	2	3	5	0	0	[illegible]0
Colorado River:							
Loma, Colo	—	47	48	95	2	12	14
Page, Ariz	2.3	—	—	—	—	—	—
Boulder City, Nev	—	1	16	17	<1	9	9
Parker Dam, Calif	—	2	8	10	0	6	6
Yuma, Ariz	—	0	4	4	3	5	8
Columbia River:							
Wenatchee, Wash	—	0	4	4	0	1	1
Pasco, Wash	—	13	199	212	0	0	0
Bonneville Dam, Oreg	—	0	106	106	0	4	4
Clatskanie, Oreg	1.1	10	90	100	1	1	2
McNary Dam, Oreg	—	12	111	123	0	1	1
Connecticut River: Northfield, Mass	—	0	4	4	1	0	1
Cumberland River: Clarksville, Tenn	—	1	3	4	0	0	0
Delaware River:							
Martins Creek, Pa	0.4	2	4	6	0	0	0
Philadelphia, Pa	—	0	4	4	0	0	0
Escambia River: Century, Fla	—	8	5	13	0	0	0
Great Lakes:							
Buffalo, N. Y	—	3	10	13	0	0	0
Port Huron, Mich	—	7	9	16	0	0	0
Milwaukee, Wis	0.3	2	4	6	0	0	0
Gary, Ind	—	1	1	2	0	0	0
Hudson River: Poughkeepsie, N. Y	0.5	2	4	6	—	—	—
Illinois River: Peoria, Ill	—	6	0	6	1	1	2
Kanawha River: Winfield Dam, W. Va	—	2	0	2	1	1	2
Klamath River: Copco, Oreg	0.3	4	1	5	0	0	0
Little Miami River: Cincinnati, Ohio	—	1	8	9	1	<1	1
Merrimack River: Lowell, Mass	—	1	0	1	0	0	0
Mississippi River:							
Minneapolis, Minn	—	0	4	4	1	2	3
Dubuque, Iowa	—	0	7	7	0	1	1
Burlington, Iowa	—	10	8	18	2	1	3
E. St. Louis, Ill	0.5	0	7	7	1	1	2
Cape Girardeau, Mo	—	20	8	28	5	4	9
West Memphis, Ark	—	13	13	26	6	1	7
Delta, La	—	23	12	35	5	0	5
New Orleans, La	0.6	2	12	14	1	0	1
Missouri River:							
Williston, N. Dak	—	8	1	9	5	4	9
Bismarck, N. Dak	0.6	0	9	9	1	3	4
Yankton, S. Dak	—	0	12	12	1	3	4
Omaha, Neb	0.7	22	26	48	3	5	8
St. Joseph, Mo	—	8	29	37	11	4	15
Kansas City, Kans	—	17	19	36	4	3	7
St. Louis, Mo	—	35	10	45	16	1	17
Monongahela River: Pittsburgh, Pa	—	2	6	8	0	1	1
North Platte River: Henry, Neb	—	0	5	5	0	16	16
Ohio River:							
East Liverpool, Ohio	—	1	1	2	0	0	0
Huntington, W. Va	—	3	8	11	0	1	1
Cincinnati, Ohio	—	5	11	16	2	1	3
Louisville, Ky	—	6	3	9	2	<1	2
Evansville, Ind	—	5	4	9	1	0	1
Cairo, Ill	—	6	9	15	3	1	4
Ouchita River: Bastrop, La	—	5	11	16	0	1	1
Potomac River:							
Williamsport, Md	0.8	2	5	7	0	0	0
Great Falls, Md	—	3	8	11	0	1	1
Platte River: Plattsmouth, Neb	—	11	11	22	5	3	8
Red River, North: Grand Forks, N. Dak	1.5	—	—	—	—	—	—
Red River, South:							
Index, Ark	—	0	13	13	0	4	4
Denison, Tex	—	0	0	0	0	1	1
Alexandria, La	—	10	11	21	1	0	1
Rio Grande:							
Alamosa, Colo	—	4	10	14	1	3	4
El Paso, Tex	—	4	10	14	6	5	11
Laredo, Tex	—	72	7	79	34	4	38
Brownsville, Tex	0.3	8	21	29	2	4	6
Roanoke River: John H. Kerr Reservoir & Dam, Va	—	2	4	6	<1	0	<1
Sabine River: Ruliff, Tex	0.8	—	—	—	—	—	—
St. Lawrence River: Massena, N. Y	—	0	0	0	1	0	1
Savannah River:							
Port Wentworth, Ga	0.5	7	17	24	0	0	0
North Augusta, S. C	0.5	0	0	0	0	0	0
Snake River:							
Wawawai, Wash	—	0	19	19	0	1	1
Weiser, Idaho	—	1	8	9	0	3	3
South Platte River: Julesburg, Colo	—	42	54	96	6	34	40
Susquehanna River: Conowingo, Md	—	0	16	16	0	0	0
Tennessee River:							
Chattanooga, Tenn	—	4	53	57	—	—	—
Bridgeport, Ala	0.9	3	38	41	0	1	1
Yakima River: Richland, Wash	—	1	10	11	0	2	2
Yellowstone River: Sidney, Mont	0.8	8	13	21	0	4	4

[a] Dash denotes no sample received or no determinations made.

All data reported in table 1 represent the average of all information available for the period indicated. Reported strontium-90 data are the results of determinations on three-month composite samples for a quarter ending in the month shown. The data were determined on analytical schedules in effect till September 1, 1961.

Additional information and data may be obtained from the following sources:

(1) *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, Water Years 1957–58, 1958–59, 1959–60. Public Health Service, Division of Water Supply and Pollution Control, Washington 25, D.C.

(2) "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167–169.

(3) Setter, L. R., J. E. Regnier, and A. Diephaus, "Radioactivity of Surface Waters in the United States," *J. AWWA 51*, 1377 (1959).

(4) Straub, C. P., L. R. Setter, A. Goldin, and P. F. Hallbach, "Strontium-90 in Surface Waters," *J. AWWA 52*, 756 (1960).

(5) Setter, L. R., and S. L. Baker, "Radioactivity of Surface Waters in the United States," *Radiological Health Data*, Vol. I, No. 7 (1960).

(6) Straub, C. P., "Significance of Radioactivity Data," *J. AWWA, 53*, 704 (1961).

SECTION V. — OTHER DATA

External Gamma Activity

Radiation Surveillance Network, Public Health Service

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately three feet above the ground. These readings are not precise, but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY, NOVEMBER 1961

Station location		Average (mr/hr)	Station location		Average (mr/hr)
City	State		City	State	
Adak	Alaska	0.01	Lansing	Mich	0.02
Anchorage	Alaska	0.01	Minneapolis	Minn	0.01
Attu	Alaska	0.01	Jackson	Miss	0.01
Barrow	Alaska	0.01	Pascagoula	Miss	0.01
Cold Bay	Alaska	0.01	Jefferson City	Mo	0.01
Fairbanks	Alaska	0.01	Helena	Mont	0.03
Juneau	Alaska	0.02	Lincoln	Nebr	0.01
Kodiak	Alaska	0.01	Trenton	N. J	0.02
Nome	Alaska	0.01	Santa Fe	N. Mex	0.03
St. Paul Island	Alaska	0.02	Albany	N. Y	0.03
Phoenix	Ariz	0.02	Gastonia	N. C	0.02
Little Rock	Ark	0.01	Bismarck	N. Dak	0.01
Berkeley	Calif	0.02	Columbus	Ohio	0.01
Denver	Colo	0.02	Oklahoma City	Okla	0.01
Hartford	Conn	0.01	Ponca City	Okla	0.04
Washington	D. C	0.02	Portland	Oreg	0.02
Jacksonville	Fla	0.01	Harrisburg	Pa	0.01
Miami	Fla	0.01	San Juan	P. R	0.01
Atlanta	Ga	0.03	Providence	R. I	0.02
Agana	Guam	0.02	Columbia	S. C	0.02
Honolulu	Hawaii	0.03	Pierre	S. Dak	0.02
Boise	Idaho	0.02	Nashville	Tenn	0.01
Springfield	Ill	0.01	Austin	Tex	0.01
Indianapolis	Ind	0.01	El Paso	Tex	0.02
Iowa City	Iowa	0.03	Salt Lake City	Utah	0.02
Topeka	Kans	0.02	Richmond	Va	0.02
Frankfort	Ky	0.01	Seattle	Wash	0.01
New Orleans	La	0.02	Madison	Wis	0.01
Baltimore	Md	0.02	Cheyenne	Wyo	0.02
Lawrence	Mass	0.02			

Global Integrals of Strontium-90 in Fallout, January 1958 - December 1960[1]

Kosta Telegadas
U.S. Weather Bureau

The monthly worldwide strontium-90 fallout for the period June 1958-May 1960 as determined from the pot and ion-exchange collectors has been reported in earlier HASL reports (*1, 2, 3*), and the September 1961 *Radiological Health Data.* This article is an expansion of those reports to cover a three year period, January 1958-December 1960.

Monthly collections are continuing, but as of May 1960, because of the low levels of activity, the samples are combined on a two month basis at most sites (*4*). As in earlier reports, two techniques were used in smoothing the data. The first consists of determining the arithmetic average of the strontium-90 deposition for each 10 degrees latitude band and drawing a smooth curve through these values. The second technique attempts to compensate for the climate differences by using the average rainfall in a latitude band.

Smoothed seasonal or bi-monthly latitudinal curves of deposition by the two techniques and for the periods under consideration are shown in figure 1. The curves in figure 1 were integrated to give the fallout in megacuries of strontium-90. The results are shown in table 1 together with those from the periods reported earlier.

It has been reported (*4*) that at four collection sites where the pot and ion-exchange collectors sampled simultaneously, a systematic difference was observed starting with the July 1960 samples. The pot collectors showed a decline in the monthly deposition of strontium-90 while the ion-exchange collectors did not. This systematic difference was attributed to contamination of the resin with strontium-90 in the ion-exchange collector and therefore, a constant value of 0.24 mc/mi^2 was subtracted from the observed values of the ion-exchange sample starting in July 1960. In the period where the constant correction was applied to the ion-exchange collectors more samples were reported as having zero activity than in the earlier period. It may be that the ion-exchange correction is not applicable to all columns and therefore, in this report the analyses from July 1960 on was essentially based on the pot data.

No attempt is made to estimate the reliability of the anlyses. It should be pointed out that it is difficult to evaluate the uncertainties in assuming that the arithmetic average of selected stations is representative of the average value for the whole latitude band and in assuming that the average latitudinal rainfall is the same as that which occurred for the time period under consideration. In the estimation of the total strontium-90 deposition, it should be mentioned that in addition to the uncertainties mentioned above, virtually no samples were taken north of 60° N latitude or south of 40° S latitude. In estimating deposition in these latitude bands a subjective analysis was used where essentially the trend of activity at other latitude bands was extrapolated to higher latitudes.

Between the cessation of large scale nuclear testing in 1958 and the resumption of testing in 1961, a number of papers had been written on the distribution of fallout on the earth's surface. One feature of the surface fallout which has been observed by many is the seasonal variation in the rate of fallout, a maximum in the spring and a minimum in the fall. This seasonal variation has been attributed principally to the seasonal changes in the atmosphere. To show this seasonal variation of surface fallout the bi-monthly and seasonal strontium-90 deposition for the Northern and Southern Hemispheres listed in table 1 was plotted on a time scale and shown in figure 2. It can be seen that in the Northern Hemisphere the spring maximum and fall minimum are clearly indicated. The Southern Hemisphere seasonal effect is not as well marked, which can probably be attributed to several causes. There are few sampling sites in the Southern Hemisphere with virtually no observations south to 40° latitude. If more sampling sites were available the seasonal changes might show up more clearly. Another factor which may help mask seasonal effect are the low levels of activity in

[1] From *Quarterly Summary Report, HASL 115,* October 1, 1961.

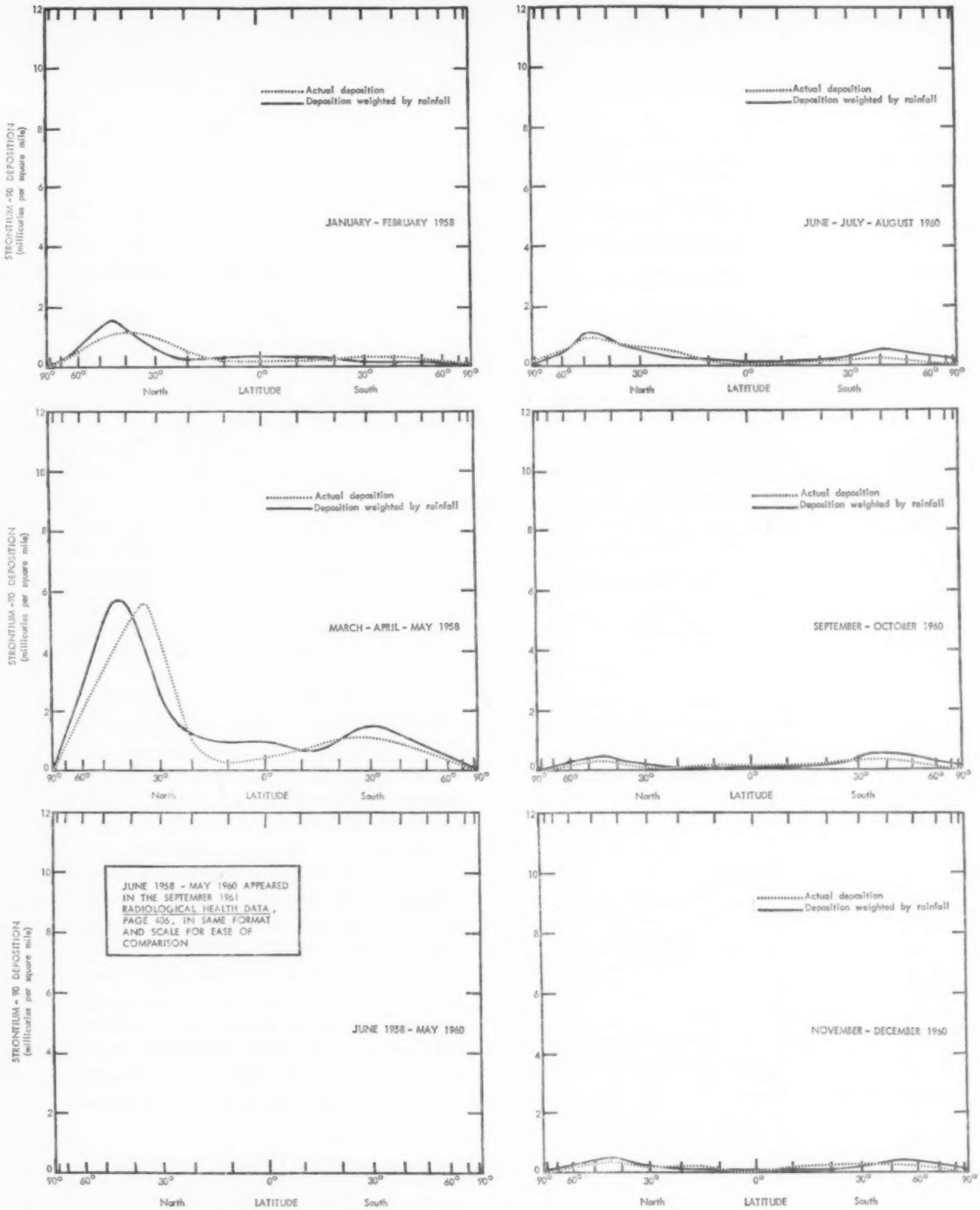


FIGURE 1.—SEASONAL LATITUDINAL CURVES OF STRONTIUM-90 DEPOSITION

(JANUARY–MAY 1958, JUNE–DECEMBER 1960)

TABLE 1.—TOTAL WORLD GROUND DEPOSITION OF STRONTIUM-90, JANUARY 1958–DECEMBER 1960

[Deposition in megacuries]

Period	Method	North latitude			South lat.	Total	Average total
		90°–30°	30°–0°	90°–0° Total	0°–90°		
Jan.–Feb. 1958	Actual deposition	0.04	0.02	0.06	0.02	0.08	0.09
	Deposition weighted by rainfall	0.05	0.02	0.07	0.02	0.09	
Mar.–May 1958	Actual deposition	0.15	0.05	0.20	0.06	0.26	0.29
	Deposition weighted by rainfall	0.18	0.06	0.24	0.08	0.32	
June–Aug. 1958	Actual deposition	0.13	0.05	0.18	0.04	0.22	0.26
	Deposition weighted by rainfall	0.19	0.03	0.22	0.07	0.29	
Sep.–Nov. 1958	Actual deposition	0.06	0.04	0.10	0.07	0.17	0.19
	Deposition weighted by rainfall	0.09	0.02	0.11	0.09	0.20	
Dec. 1958–Feb. 1959	Actual deposition	0.15	0.06	0.21	0.07	0.28	0.29
	Deposition weighted by rainfall	0.16	0.06	0.22	0.07	0.29	
Apr.–May 1959	Actual deposition	0.34	0.12	0.46	0.05	0.51	0.52
	Deposition weighted by rainfall	0.37	0.08	0.45	0.07	0.52	
June–Aug. 1959	Actual deposition	0.16	0.04	0.20	0.03	0.23	0.25
	Deposition weighted by rainfall	0.16	0.04	0.20	0.06	0.26	
Sep.–Nov. 1959	Actual deposition	0.06	0.03	0.09	0.03	0.12	0.12
	Deposition weighted by rainfall	0.04	0.03	0.07	0.05	0.12	
Dec. 1959–Feb. 1960	Actual deposition	0.037	0.026	0.063	0.041	0.104	0.110
	Deposition weighted by rainfall	0.042	0.026	0.068	0.047	0.115	
Mar.–May 1960	Actual deposition	0.056	0.037	0.093	0.033	0.126	0.139
	Deposition weighted by rainfall	0.074	0.037	0.110	0.042	0.153	
June–Aug. 1960	Actual deposition	0.034	0.018	0.052	0.023	0.075	0.079
	Deposition weighted by rainfall	0.034	0.017	0.052	0.029	0.080	
Sep.–Oct. 1960	Actual deposition	0.010	0.007	0.017	0.025	0.042	0.047
	Deposition weighted by rainfall	0.015	0.006	0.021	0.030	0.051	
Nov.–Dec. 1960	Actual deposition	0.011	0.008	0.019	0.021	0.040	0.044
	Deposition weighted by rainfall	0.016	0.007	0.023	0.024	0.047	
Total Jan. 1958–Dec. 1960							2.43

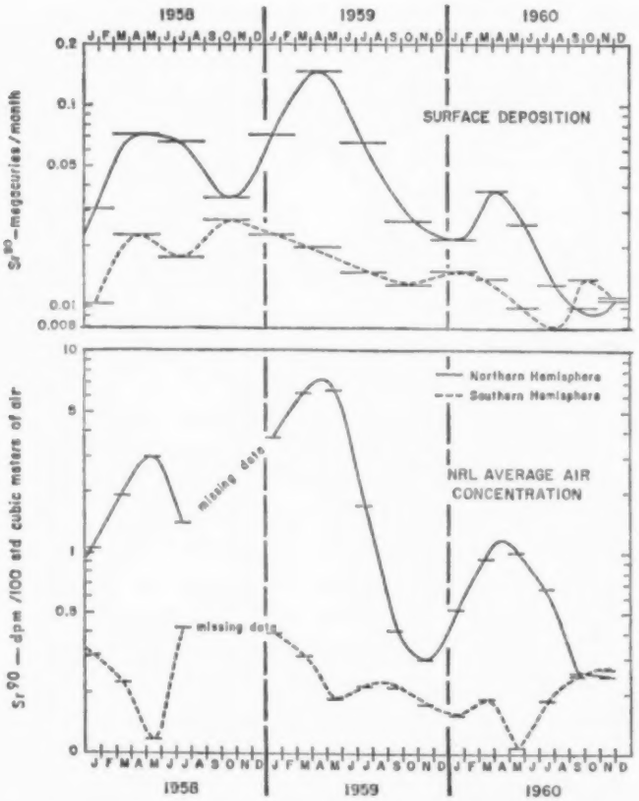


FIGURE 2.—COMPARISON OF SURFACE FALLOUT DEPOSITION TO GROUND LEVEL AIR CONCENTRATIONS

the Southern Hemisphere. Also there may be a real difference in the meteorology of the two hemispheres.

For comparison purposes the Naval Research Laboratory hemispheric ground level air concentrations of strontium-90, which were arrived at by averaging the monthly ground level air concentrations taken along the 80th Meridian (West) are also shown in figure 2 (*5, 6, 7*). In general, both the surface deposition and air concentration data show that the Northern and Southern Hemispheres are out of phase, the levels of activity in the Northern Hemisphere are greater than in the Southern Hemisphere and that beginning in late 1960 the levels of activity in the Southern and Northern Hemispheres are about equal.

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(*2*) Telegadas, K., "Global Integrals of Monthly Sr^{90} Fallout, June–November 1959," HASL–95, p. 164, October 1, 1960.

(*3*) Telegadas, K., "Global Integrals of Monthly Sr^{90} Fallout, December 1959–May 1960," HASL–111, p. 159, April 1, 1961.

(*4*) Hardy, E. P., Jr., J. Rivera, and R. Frankel, *Fallout Program*, HASL–113, p. 2, July 1, 1961.

(5) Lockart, L. B., Jr., R. A. Baus, R. L. Patterson, Jr., and A. W. Saunders, Jr., "Radiochemical Analyses of Air-Filter Samples Collected During 1958," NRL Report 5390, October 23, 1960.

(6) Lockhart, L. B., Jr., R. L. Patterson, Jr., A. W. Saunders, Jr., and R. W. Black, "Fission Product Radioactivity in the Air Along the 80th Meridian (West) During 1959," NRL Report 5528, August 1960.

(7) Lockhart, L. B., Jr., R. L. Patterson, Jr., A. W. Saunders, Jr., and R. W. Black, "Fission Product Radioactivity in the Air Along the 80th Meridian (West) During 1960," NRL Report 5692, August 1961.

Environmental Monitoring in Alaska

Project Chariot
Atomic Energy Commission

In May 1959 the United States Atomic Energy Commission approved a program of environmental studies to be conducted in conjunction with a proposed excavation project using nuclear explosives (Project Chariot, Plowshare Program) at the mouth of Ogotoruk Creek near Cape Thompson, Alaska.

The proposed project, which is under study and for which the detonations have not been approved, would involve the simultaneous detonation of five nuclear devices. Four 20-kiloton devices would be buried to about 400 feet and one 200 kiloton device buried to about 800 feet. The detonation of the four smaller devices would be expected to produce a channel about 900 feet wide and 2,000 feet long, with a basin about 1800 feet in diameter resulting from explosion of the larger device. It is expected that about 95 percent of the fission products will be entrapped underground.

After the USSR resumed testing on September 1, 1961, four fallout monitoring stations were activated at Cape Thompson, Kivalina, Kotzebue and Point Hope, as shown in figure 1.

Table 1 presents the October results. The December 1961 *Radiological Health Data* presented the September results. No water samples were taken during October. The high values for samples taken at Cape Thompson for the period October 8-11 have been re-checked. The decay rates on these samples was very rapid, indicating very fresh fission product material. There is no explanation, at present, for the Cape Thompson levels being so much higher than the other stations during that period.

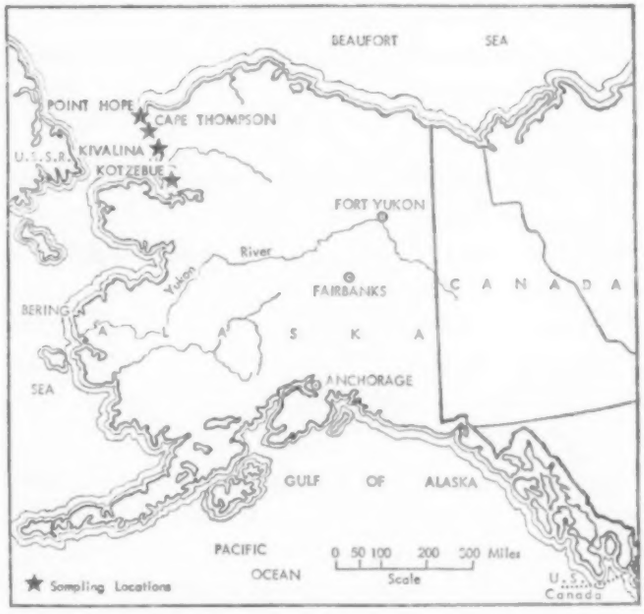

FIGURE 1.—SAMPLING LOCATIONS FOR PROJECT CHARIOT

TABLE 1.—GROSS BETA ACTIVITY IN ALASKAN AIR SAMPLES, OCTOBER 1961

End of sampling period	Cape Thompson		Kivalina		Kotzebue		Point Hope	
	Sampling time (hours)	Gross beta ($\mu\mu c/m^3$)	Sampling time (hours)	Gross beta ($\mu\mu c/m^3$)	Sampling time (hours)	Gross beta ($\mu\mu c/m^3$)	Sampling time (hours)	Gross beta ($\mu\mu c/m^3$)
October 1	[a] —	—	6.8	10.5	26.6	16.4	13.0	4.21
2	22.5	6.77	3.3	3.31	21.8	3.96	14.5	17.1
3	—	—	5.0	1.38	23.6	4.04	13.5	1.31
4	24.1	2.62	4.5	2.62	24.1	3.93	14.5	2.36
5	31.5	10.0	5.5	3.20	23.8	2.47	—	—
6	—	—	6.8	2.87	25.1	2.13	15.3	2.69
7	44.7	1.09	2.1	9.8	23.1	2.76	10.2	1.44
8	28.6	2.78	4.2	1.20	24.4	8.75	11.8	3.61
9	24.3	106.0	4.8	0.50	23.7	5.49	11.4	7.98
10	18.2	205.0	4.3	2.48	24.2	5.00	14.2	1.51
11	27.0	273.0	4.5	1.16	24.3	3.52	14.3	1.34
12	24.0	1.81	5.5	3.21	23.9	10.9	14.8	1.96
13	21.7	1.85	4.9	6.14	24.0	1.44	14.3	3.41
14	24.5	2.12	3.2	2.01	24.1	4.83	8.0	3.12
15	—	—	6.5	99.0	24.3	1.10	1.8	20.8
16	40.5	1.58	4.0	5.90	23.5	5.33	8.2	27.1
17	34.9	10.9	5.7	3.16	24.0	7.41	13.2	5.28
18	24.0	4.88	6.2	27.9	26.7	5.34	13.1	24.3
19	—	—	6.7	0.16	20.9	1.12	12.8	0.35
20	24.3	21.0	0.4	20.2	23.9	6.74	13.8	2.20
21	—	—	4.5	1.17	23.7	3.39	10.5	0.38
22	—	—	4.2	1.74	—	—	13.0	1.74
23	23.9	0.59	4.9	0.42	21.2	1.09	13.2	0.21
24	24.0	0.56	5.4	0.18	24.1	0.57	13.6	0.30
25	23.9	0.67	5.7	0.31	24.3	0.22	14.6	0.28
26	23.5	0.20	3.0	1.14	23.6	0.98	12.0	1.72
27	—	—	1.5	0.16	24.1	3.74	12.8	1.05
28	28.0	0.68	3.7	1.00	25.6	7.07	6.8	0.34
29	18.0	1.28	2.5	0.28	23.4	3.05	12.2	0.95
30	29.6	2.66	1.5	3.84	23.2	3.39	12.3	5.07
31	24.3	3.57	—	—	24.0	1.47	12.0	0.89

[a] Dash indicates no sample received.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission transmits to the Public Health Service quarterly reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 19 AEC installations have appeared in *Radiological Health Data* since the November 1960 issue. Summaries follow for Hanford Atomic Products Operation for third and fourth quarters 1960 and first and second quarters 1961; and Portsmouth Area Gaseous Diffusion Plant and Savannah River Plant for first and second quarters 1961.

The measured concentrations of radioactive substances in air and water may be compared with the Maximum Permissible Concentration (MPC) of that substance as recommended by the National Committee on Radiation Protection and Measurements (NCRP). For the environment near an AEC installation the applicable MPC's are one-tenth of the occupational values for continuous exposure as given in National Bureau of Standards Handbook 69.

TABLE 1.— SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line No.	Radioactive substance	Environmental MPC	
		Water ($\mu\mu c$/liter)	Air ($\mu\mu c/m^3$)
1	Arsenic-76	20,000	3,000
2	Chromium-51	2,000,000	80,000
3	Hydrogen-3 (tritium)	3,000,000	200,000
4	Iodine-131	2,000	300
5	Neptunium-239	100,000	20,000
6	Phosphorus-32	20,000	2,000
7	Strontium-90	100	10
8	Thorium-234	20,000	1,000
9	Uranium, natural	20,000	2
10	Zinc-65	100,000	2,000

Another guide by which environmental levels may be evaluated is the Radioactivity Concen-

tration Guide (RCG) recommended by the Federal Radiation Council. For most nuclides an RCG is numerically equal to the corresponding MPC.

For the purpose of clarity and perspective, a few of the applicable environmental MPC (or RCG) values are listed in table 1. Such values are intended as guides only. For further clarification, Handbook 69 and FRC Report No. 1 should be consulted.

The estabishment of MPC's does not imply that each nuclide may be present at 100% of its MPC concentration. If the concentration of each nuclide is expressed in terms of percent of its MPC, then the sum of all the percent values should not exceed 100%.

Hanford Atomic Products Operation

General Electric Company
Richland, Washington

Third Quarter 1960 Through Second Quarter 1961
Issued October 1961

Previous Coverage in *Radiological Health Data*:

Period covered:	*Issue:*
1959 and first and second quarter 1960	May 1961

During the operation of the plutonium production and research facilities at Hanford, controlled amounts of radioactive wastes are released to the atmosphere, ground, and the Columbia River. This report presents an analysis of data from the environmental sampling program designed to check the effectiveness of the control measures. In addition to the results for the twelve month period covered by this report, some earlier results will be shown for comparison. Figure 1 shows the relationship of the Hanford facilities to the surrounding communities.

Air Wastes Monitoring

Exposures from releases of air-borne contaminants via stacks to the atmosphere were small and are not included in figures 4, 5 and 6. Iodine-131 is the radionuclide of process offgas origin which is of particular interest. The emission rate for I^{131} released to the atmosphere is shown in figure 2. The local control limit for release of I^{131} is 10 curies per seven days. At the release rate observed, no significant depositions on native vegetation were expected or found.

Routine measurements of I^{131} in air at Richland, North Richland, Pasco, and Benton City indicate that the average concentration in air for the 12 months ending with June of 1961 was less than 0.03 $\mu\mu c\ I^{131}/m^3$. A sustained concentration of I^{131} of this magnitude in inspired air would imply an annual exposure to the thyroid of the standard man of about 0.3 mrad.

Concentrations of I^{131} may be several orders of magnitude greater in the thyroid of grazing animals than in their food. Consequently, the radioassay of beef cattle thyroids is useful in the study of effects of low level I^{131} emssions. Occurrences of I^{131} in cattle thyroids from the Pasco slaughterhouse are shown in figure 3. No samples were obtained in June.

Water Waste Monitoring

The principal source of exposure continues to be identified with radionuclides in reactor cooling water discharged to the Columbia River. For individuals whose habits regularly include drinking water from Pasco's public supply, ingesting of local fish and waterfowl, and consuming produce from local farms, an intake of bone-seeking radionuclides is estimated at about 40 per cent of that recommended by the National Committee on Radiation Protection and Measurements (NCRP) as maximum for continuous intake by persons in the neighborhood of controlled areas. The dose of the GI tract from drinking Pasco water for the 12 months ending with June of 1961 is calculated as about 90 mrems, which amounts to 6 percent of the recommended maximum permissible limit.

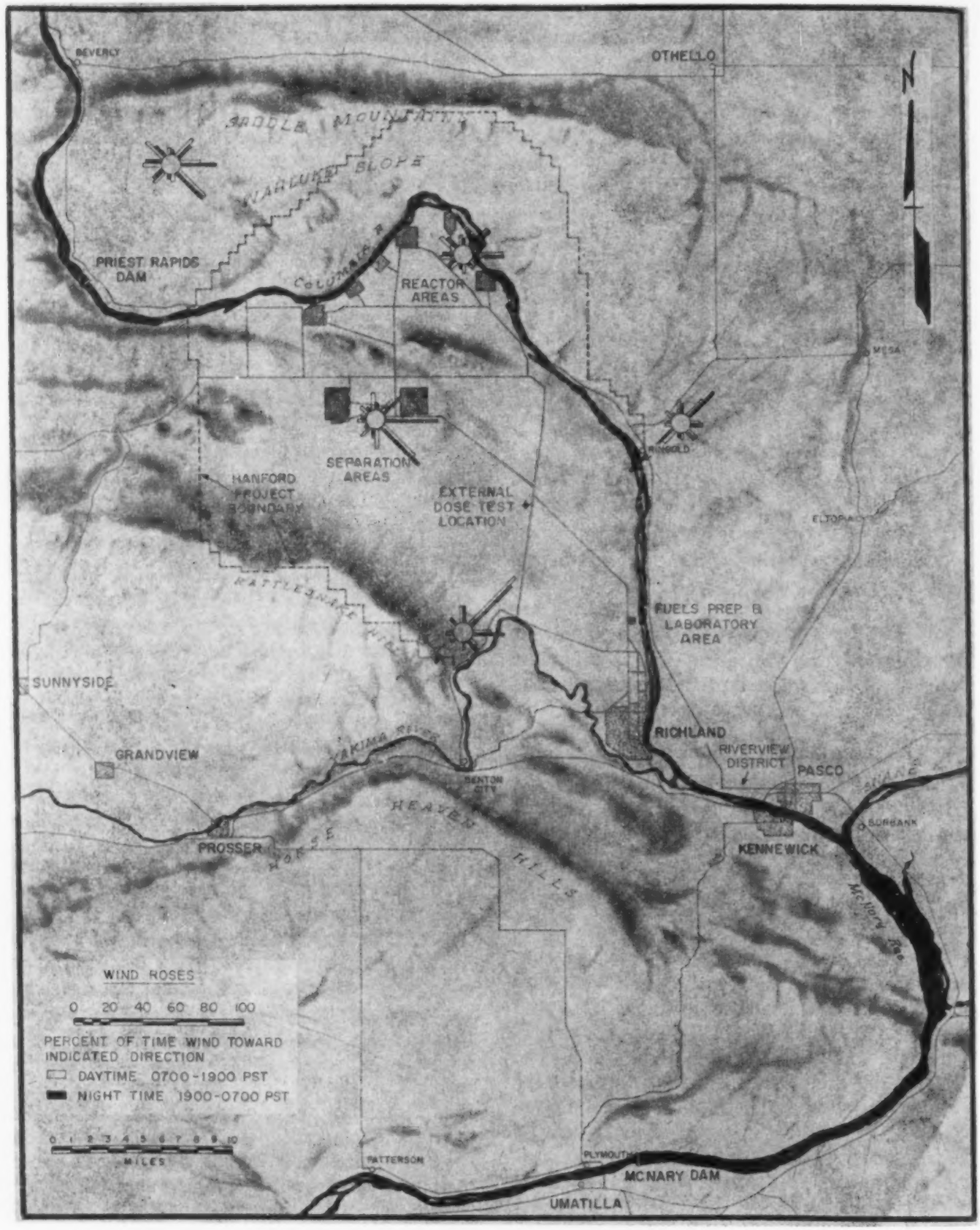

FIGURE 1.—FEATURES OF THE HANFORD OPERATION AND VICINITY

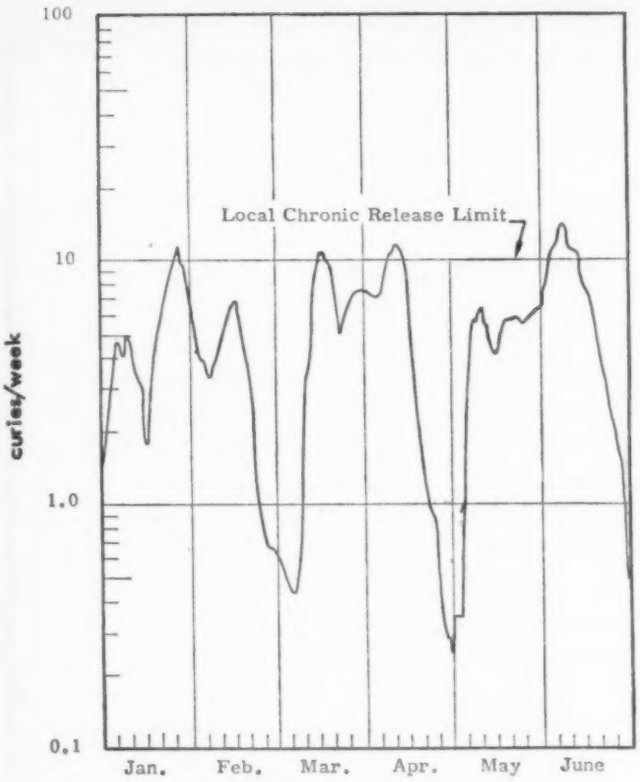

FIGURE 2.—RELEASE OF I^{131} TO THE ATMOSPHERE, 1961

The 1960 estimates of dose received by persons in neighboring communities are represented graphically in figures 4, 5 and 6 for the GI tract, bone, and total body, respectively. In

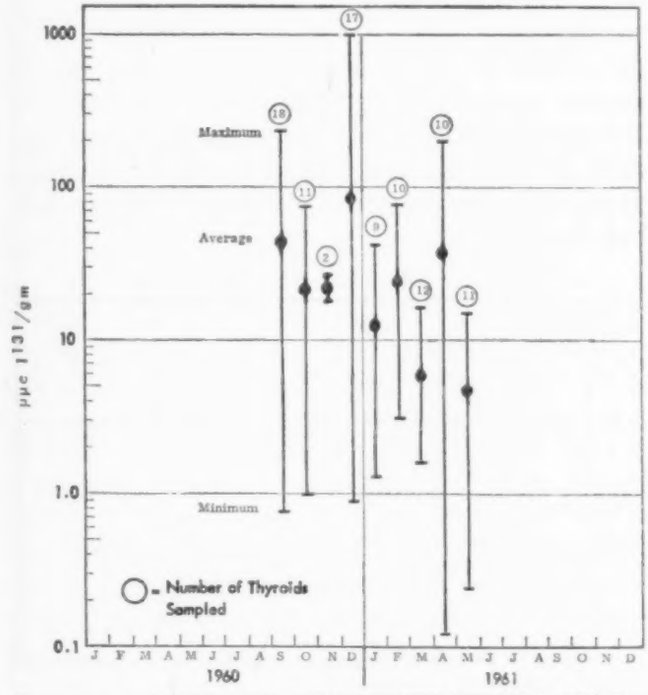

FIGURE 3.—AVERAGE CONCENTRATIONS OF I^{131} IN BEEF CATTLE THYROIDS FROM PASCO SLAUGHTER HOUSE

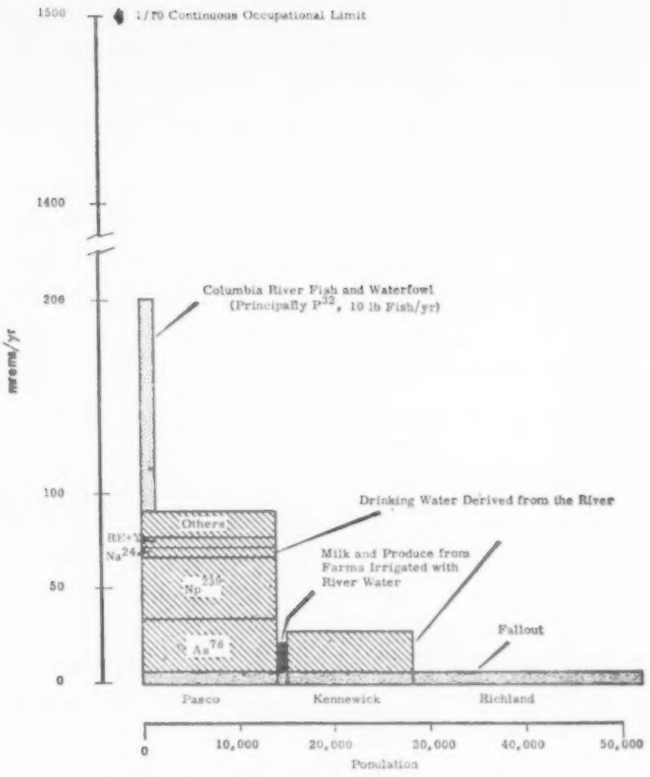

FIGURE 4.—CALCULATED DOSE TO THE HUMAN GI TRACT, 1960

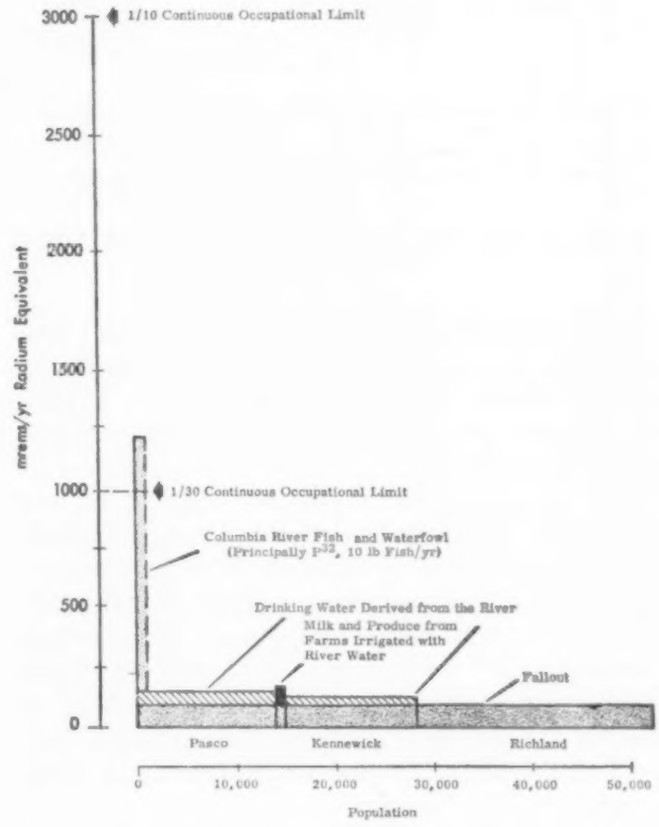

FIGURE 5.—CALCULATED DOSE TO HUMAN BONE, 1960

the figures, the vertical scale is dose in mrems per year and the horizontal scale indicates the number of people involved. Various limits also are indicated and the several sources of exposure are identified.

The principal exposures attributable to Hanford results from ingesting local fish from the Columbia River, drinking water at Pasco and Kennewick, and eating produce from the few

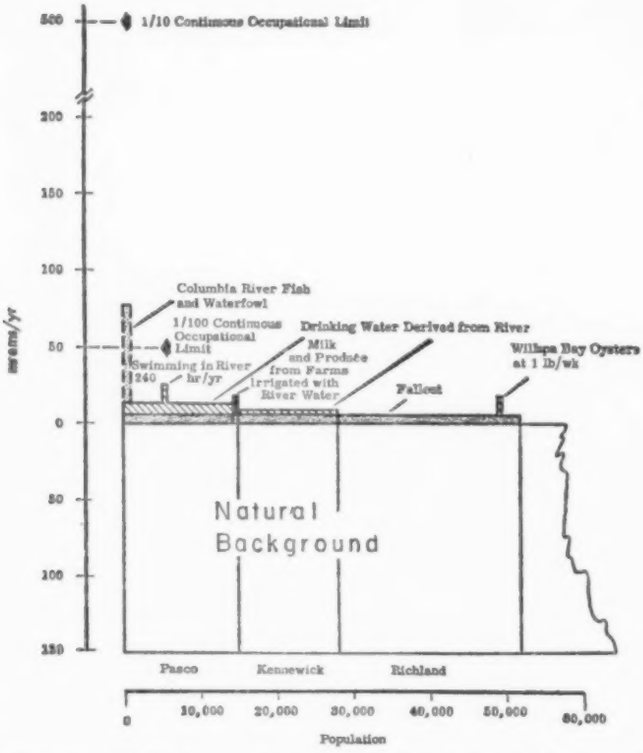

FIGURE 6.—CALCULATED DOSE TO TOTAL BODY OF MAN, 1960

farms irrigated with river water. A small contribution to dose in the case of each of the body organs results from worldwide fallout. Figure 6 includes the dose estimated from natural background sources.

At present, the exposure from fish and waterfowl can only be estimated for hypothetical persons. The illustration is based on consumption of 10 pounds per year of whitefish caught in the Hanford-Ringold area which contained P^{32} in amounts indicated in 1960. While the dose from fish and waterfowl is shown for an individual in Pasco, there may be individuals with similar exposures in Kennewick and Richland.

The data collected over several years on the beta emitters (nearly all P^{32}) in whitefish in

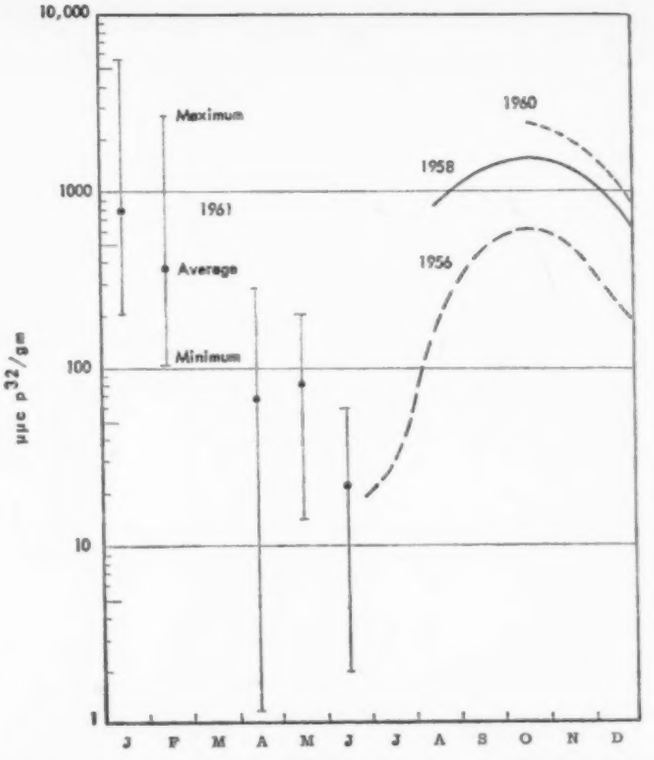

FIGURE 7.—PHOSPHORUS-32 IN COLUMBIA RIVER WHITEFISH, HANFORD FERRY TO RICHLAND

the Hanford-Ringold area are presented in figure 7. Current measurements on whitefish include radioassay specifically for P^{32} and several other radionuclides. The concentrations of P^{32} in the fish vary considerably with the season and reach a maximum in late fall. The reduction in the concentration of P^{32} in the second quarter is a reflection of a seasonal trend associated with water temperature and flow rate. Unusually high river flows hampered fish sampling in the Columbia River during June.

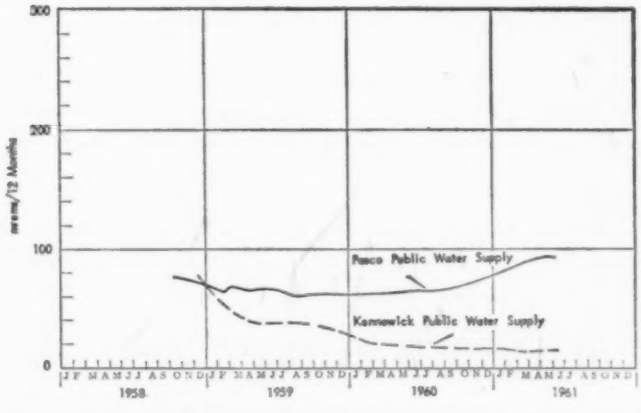

FIGURE 8.—TRENDS IN CALCULATED DOSE TO THE GI TRACT

The 12 months calculated dose for the GI tract from drinking water at Pasco and Kennewick are shown in figure 8. The increasing trend in dose from Pasco sanitary water is considered to be caused primarily by changes in the reactor effluent releases. The dose to Kennewick water drinkers remains at about 15 mrems per year. The smaller dose from Kennewick water is believed to be due to dilution by water from the Yakima River flowing along the Kennewick side of the Columbia River.

The seasonal changes in the concentrations of several of the more important radionuclides in Columbia River water, as measured at Pasco for the last few years, are illustrated in figure 9. The low concentrations in June and July are caused by high water in the Columbia River and are not due to process changes.

Zinc-65 is a reactor effluent radionuclide which persists in the Columbia River to the ocean and is concentrated in certain shellfish, particularly oysters. Oysters from Willapa Bay, Washington, are sampled and analyzed regularly for Zn^{65} and other radionuclides. The average concentration of Zn^{65} in oysters during the first quarter of 1961 was 60 μμc Zn^{65}/gm, and during the second quarter, 90 μμc Zn^{65}/gm. Sustained ingestion of one pound of oysters from Willapa Bay per week for the 12 months ending with June of 1961 would have resulted in about 10 mrems to the total body.

Milk and Produce

Exposure due to ingestion of milk and produce from local farms involves a limited number of people. The Ringold farms and the Riverview District take water from the river below the reactors and some of the radionuclides are traced through the irrigation processes to milk and product. The Ringold farms involve about a dozen people working about 500 acres of land. Fruit and milk are the principal products of these farms with only limited production of vegetables and meat. The Riverview farming area is composed of less than 3000 acres and has about 20 to 30 families. Most of the farms are small with milk, fruit, and some vegetables as major items of produce. Other farming areas in the vicinity of Hanford are not irrigated with Columbia River water taken downstream from the reactors.

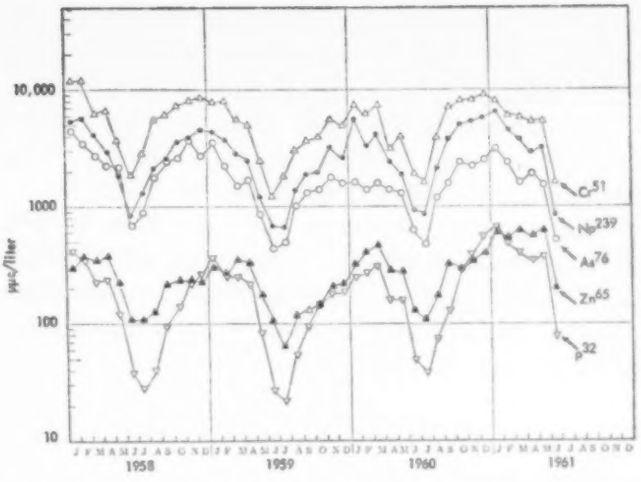

FIGURE 9.—CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN COLUMBIA RIVER WATER AT PASCO, WASHINGTON

One of the principal routes of intake of radionuclides of reactor origin for the people of Riverview and Ringold is through ingestion of milk. Phosphorus-32 and Zn^{65} are identified in milk from these areas and the milk is sampled and analyzed regularly. The amounts of these radionuclides in milk vary with release rates from the reactors, flow, irrigation practices, and other factors. Radionuclides in milk are the principal source of dose to farmers in figures 4, 5, and 6.

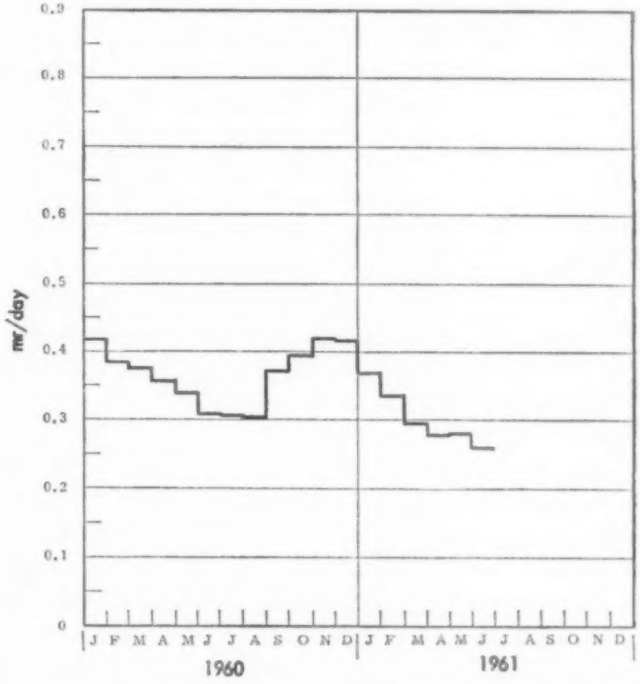

FIGURE 10.—EXTERNAL DOSE-RATE AS MEASURED AT HANFORD EXTERNAL DOSE TEST LOCATION

As a measure of worldwide fallout in the local area, the Sr^{90} content of milk from several local dairies is followed. The measurements are complicated because in many cases the amount is very near the detection limit. The concentrations vary from 2 to 6 $\mu\mu$/liter.

The observed average concentration of I^{131} in local milk for the second quarter was 60 $\mu\mu$c I^{131}/liter milk. Consumption of one liter per day of such milk for one year would result in an estimated annual dose to the thyroid (for a standard man with a 20-gram thyroid) of less than 0.05 rad.

External Dose Rate

The external dose rate, as measured with ionization chambers at the test location on the Hanford reservation, is illustrated in figure 10. The average dose rate for the 12 months ending with June of 1961 was 0.34 mr per day as compared to 0.40 mr per day for the calendar year 1960.

Portsmouth Area Gaseous Diffusion Plant

Goodyear Atomic Corporation
Portsmouth, Ohio

First and Second Quarters 1961
Issued August 1961

Previous Coverage in *Radiological Health Data*:

Period covered:	*Issue:*
1959 and first quarter 1960	November 1960
Second and third quarters 1960	March 1961
Fourth quarter 1960	August 1961

The gaseous diffusion process for separation of uranium isotopes requires a high degree of control to minimize the release of toxic and radioactive substances to the environment. The most likely radionuclides to be released to the environment are natural uranium (an alpha emitter) and thorium-234 (a beta-gamma emitter) the daughter of uranium-238. Environmental monitoring of alpha and beta gamma activities would therefore detect any concentrations of uranium or thorium-234 significantly above background activities.

Monthly air samples are collected at 15 locations varying from one to six miles from the plant site as shown in figure 11. The average alpha and beta-gamma concentrations in air are reported in table 2.

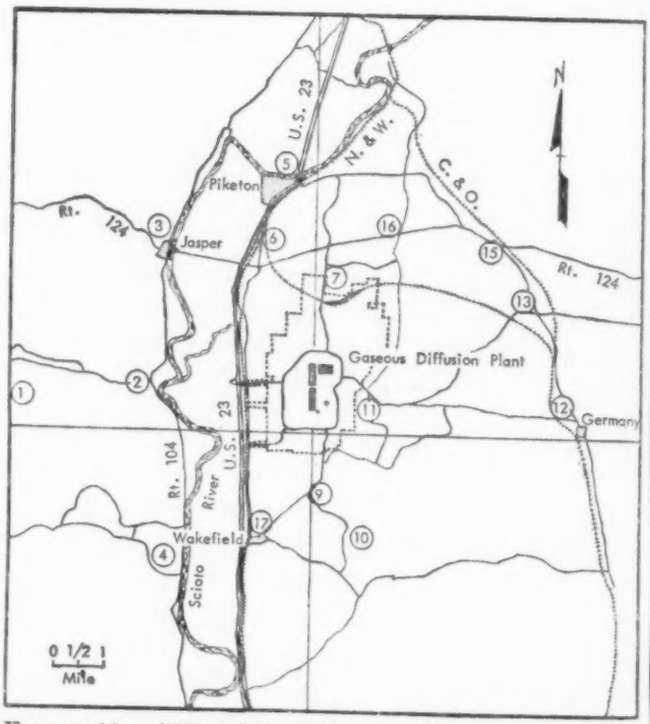

FIGURE 11.—AIR SAMPLING LOCATIONS, PORTSMOUTH GASEOUS DIFFUSION PLANT

TABLE 2.—AVERAGE LEVELS OF RADIOACTIVITY IN THE ENVIRONMENT OF THE PORTSMOUTH PLANT

Basis of measurement	First quarter 1961		Second quarter 1961	
	Number of samples	Concentration	Number of samples	Concentration
Air-alpha[1] concentration	45	0.1 $\mu\mu$c/m^3	30	0.1 $\mu\mu$c/m^3.
Air-beta-gamma[2] concentration	45	0.2 $\mu\mu$c/m^3	30	<0.007 $\mu\mu$c/m^3.
Water-alpha[1] concentration	42	13 $\mu\mu$c/liter	41	19 $\mu\mu$c/liter.
Water-beta-gamma[2] concentration	42	21 $\mu\mu$c/liter	41	32 $\mu\mu$c/liter.
Over-all background dose rate	45	0.011 mrad/hour	30	0.013 mrad/hour.

[1] The alpha concentrations may be compared with the MPC values for natural uranium as listed in table 1.
[2] The beta-gamma concentrations may be compared with the MPC values for thorium-234 as listed in table 1.

Water samples are collected monthly at 14 locations within five miles from the plant site. Average alpha and beta-gamma concentrations are given in table 2. The Scioto River showed no significant differences in upstream and downstream concentrations. Some smaller streams and drainage ditches had concentrations as high as 150 μμc α/liter and 170 μμc β-γ/liter. These values are roughly 1 percent of the environmental MPC values listed for natural uranium and thorium in table 1.

The overall background exposure levels are measured at the air sampling locations shown in figure 11.

Although the levels were higher during the second quarter than the first as shown in table 2 the trend has been a steady decrease for the past several years since the cessation of nuclear weapon tests in October 1958.

Savannah River Plant

E. I. du Pont de Nemours
Aiken, South Carolina

First and Second Quarters 1961
Issued September 1961

Previous Coverage in *Radiological Health Data*:

Period covered:	*Issue:*
1959 and First quarter 1960	December 1960
Second and third quarter 1960	May 1960
Fourth quarter 1960	August 1961

The Savannah River Plant (SRP) maintains a continuous monitoring program to determine the concentration of radioactive materials in a 1200 square-mile area outside the plant perimeter. Included are parts of Aiken, Barnwell and Allendale counties in South Carolina and Richmond, Burke and Screven Counties in Georgia. This program, initiated in 1951, prior to startup of plant operations, is carried out by the Health Physics Section of E. I. du Pont de Nemours and Company, prime contractor for operation of the plant for the Atomic Energy Commission.

The regional monitoring data obtained from continuous surveillance of the Savannah River Plant environs are useful both as measures of the effectiveness of plant controls and as evidence of the strict adherence to the recommended Radioactivity Concentration Guide Levels (RCG). Some RCG values are given in table 1.

In most cases, the very low levels of radioactivity in air, water, vegetation, milk and aquatic specimens in the immediate vicinity of the plant (detected by extremely sensitive laboratory and counting techniques) were usually too low to be distinguished from natural background or from bomb debris resulting from global weapons testing activities. Radioiodine levels showed an increase for a brief period in June at several points near the plant boundary in Aiken and Barnwell countries. Release of more than the usual amount of radioiodine from the plant's separations facilities, combined with adverse atmospheric conditions, caused this localized situation. Because radioiodine deposited on vegetation finds its way into milk, a large number of samples of vegetation and milk were collected and analyzed. Results of these analyses were well below the limits established by the National Committee on Radiation Protection.

Atmospheric Monitoring

Weekly air and rainwater samples were collected continuously at 15 monitoring stations, including 5 locations at the plant perimeter and 10 locations which circumscribe an area extending approximately 25 miles from the center of the plant. These stations, forming two concentric circles around the plant, are so spaced such that a significant plant release of radioactivity to the air would be detected regardless of prevailing wind conditions (see figure 12). Additional air monitoring stations were operated at Savannah and Macon, Georgia and at Columbia and Greenville, South Carolina. These four facilities (see figure 13) are at locations so distant (approximately 100 miles from the plant) that the effect of SRP operations is minimal. They serve as "reference

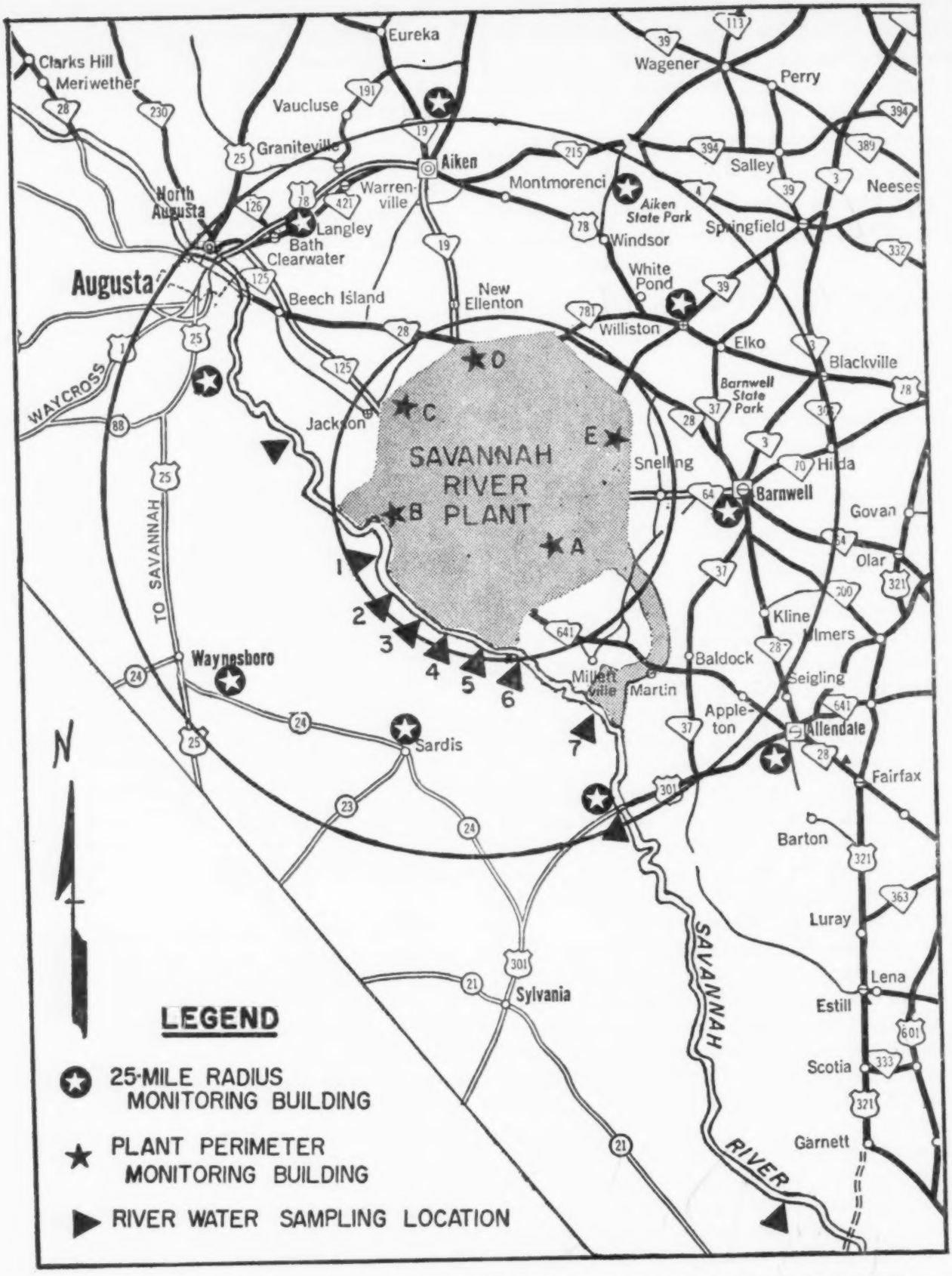

FIGURE 12.—ENVIRONMENTAL SAMPLING LOCATIONS, SAVANNAH RIVER PLANT

FIGURE 13.—DISTANT AIR MONITORING STATIONS, SAVANNAH RIVER PLANT

points" for determining background levels of activity. This system of 19 stations permits a comprehensive surveillance of the atmospheric radioactivity and, in addition, make it possible to differentiate between weapons testing fallout and plant releases. The average concentrations of radioactivity in air and in rainwater are given in tables 3 and 4.

Concentrations of iodine-131 in air observed out to the 25 mile radius circle, and projected concentrations (calculated from the amount of I^{131} released and local meteorological data) are summarized in an isoactivity map, figure 14. Because the calculated and observed data compared favorably, it is assumed that the projected data are representative of actual conditions.

TABLE 3.—RADIOACTIVITY IN AIR

[Average concentrations in $\mu\mu c/m^3$]

Period	Source of samples	Alpha	Nonvolatile beta	Iodine-131
First quarter 1961	Plant perimeter	0.0008	0.07	<0.02
	25 mile radius	0.0007	0.06	<0.02
	100 mile radius	0.0009	0.04	NS[1]
Second quarter 1961	Plant perimeter	0.0007	0.07	0.11
	25 mile radius	0.0006	0.07	0.05
	100 mile radius	0.0009	0.1	NS[1]

[1] NS = No sample.

TABLE 4.—RADIOACTIVITY IN RAINWATER

[Average concentrations in $\mu\mu c$/liter]

Period	Source of samples	Alpha	Nonvolatile beta	Iodine-131
First quarter 1961	Plant perimeter	0.5	15	<8
	25 mile radius	0.4	19	<8
Second quarter 1961	Plant perimeter	0.5	22	20
	25 mile radius	0.3	31	15

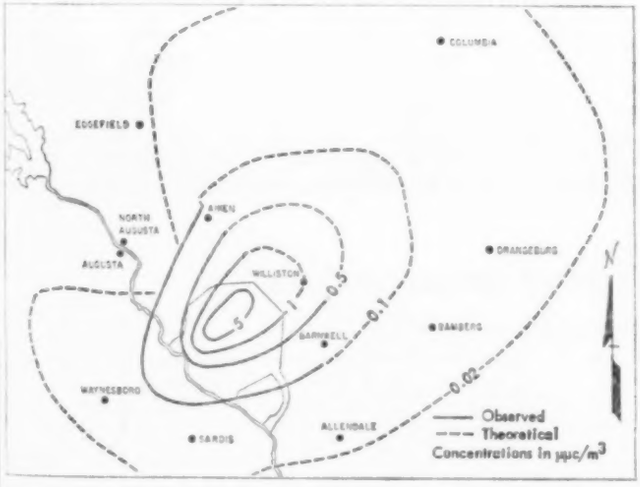

FIGURE 14.—ISOACTIVITY MAP OF IODINE-131 CONCENTRATIONS IN AIR, JUNE 1–7, 1961

Food

Fresh eggs collected during June 1961 contained an average of 33 $\mu\mu c$ I^{131}/egg. A suggested guide for I^{131} in eggs is 160,000 $\mu\mu c$/egg[1]. Peaches obtained from a farm several miles north of Aiken showed no evidence of I^{131}.

Milk

Milk samples were collected weekly from dairies and farms in Aiken, North Augusta,

[1] Horton, J. H., E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, S.C. *Suggested MPC Values for Radioiodine Isotopes in Foods*, presented at the Health Physics Society Annual Meeting, Boston, Massachusetts, June 1960.

TABLE 5.—RADIOACTIVITY IN MILK

[Average concentrations in μμc/liter]

Type of test	First quarter 1961	Second quarter 1961
Tritium (H^3)	4,000	7,000
Iodine-131	<11	60
Strontium-90:		
Single cow samples	20	30
Local dairies	12	12
Major distributors	12	13

Snelling, Talatha, and Langley, South Carolina and analyzed for tritium (H^3) and radioiodine content. Strontium-90 content of locally produced milk is determined quarterly. In addition to the milk sampling locations mentioned previously, milk from Williston and Cope, South Carolina and Waynesboro and Sylvania, Georgia was sampled and analyzed. Average concentrations of H^3, I^{131}, and Sr^{90} in milk are given in table 5. The Sr^{89}/Sr^{90} ratio determined for a single-cow sample with a high concentration of 51 μμc/liter, showed it to be aged material and not attributable to SRP.

Special milk samples from 48 individual farms and dairies in the vicinity of the plant were collected early in June. Analyses showed a wide distribution in iodine-131 concentration. The histogram in figure 15 shows the frequency distribution of the 48 farms or dairies in different I^{131} concentration ranges.

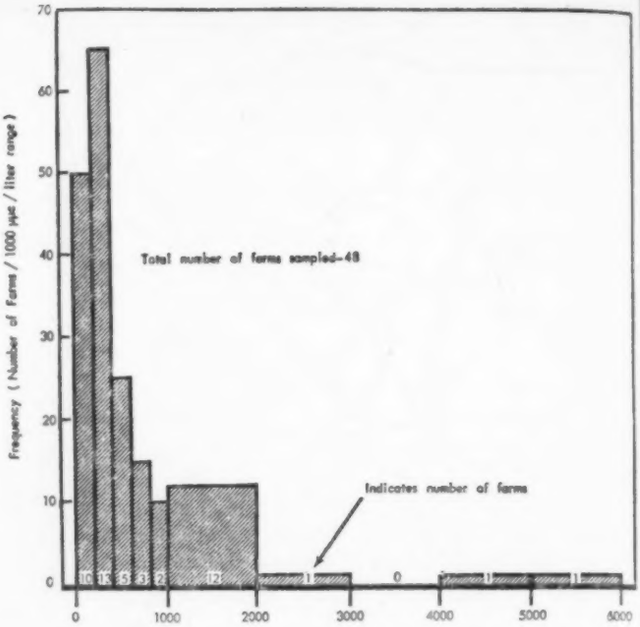

FIGURE 15.—DISTRIBUTION OF MILK SAMPLES IN VARIOUS IODINE-131 CONCENTRATION RANGES

Water Monitoring

Communities in the vicinity of SRP obtain sanitary water from deep wells or surface streams. Public water samples are collected monthly from 14 surrounding towns. Savannah River water is sampled continuously at seven locations. Six of the locations are shown in

TABLE 6.—RADIOACTIVITY IN WATER

[Average concentrations in μμc/liter]

Period	Source of samples	Alpha	Nonvolatile beta	H^3	Sr^{90}
First quarter 1961	Public water supplies	0.8	5	—	—
	Savannah River water:				
	3 miles upstream	0.3	5	4,000	0.3
	10 miles donwstream	0.2	21	13,000	0.6
Second quarter 1961	Public water supplies	1.1	6	—	—
	Savannah River Water:				
	3 miles upstream	0.3	7	4,000	0.3
	10 miles downstream	0.3	31	13,000	0.5

TABLE 7.—RADIOACTIVITY IN VEGETATION (BERMUDA GRASS)

[Average concentrations in μμc/gm]

Period	Source of samples	Alpha	Nonvolatile beta	Iodine-131
First quarter 1961	Plant perimeter	0.23	11	<0.6
	25 mile radius	0.19	8	<0.6
Second quarter 1961	Plant perimeter	0.12	16	3
	25 mile radius	0.15	14	3

figure 12; the seventh is 60 miles downstream from the plant.

Quarterly average concentrations of alpha and beta activity in public and Savannah River water is presented in table 6.

Vegetation

Bermuda grass was selected for analysis of vegetation because of its importance as a pasture grass for dairy herds and its availability during all seasons of the year. Monthly samples are collected at the 15 air monitoring locations shown in figure 12. Quarterly average concentrations of alpha, beta, and I^{131} are presented in table 7.

Special samples of Bermuda grass were collected on June 5 in order to check the extent of I^{131} deposition. Radioiodine concentrations in grass are shown in figure 16.

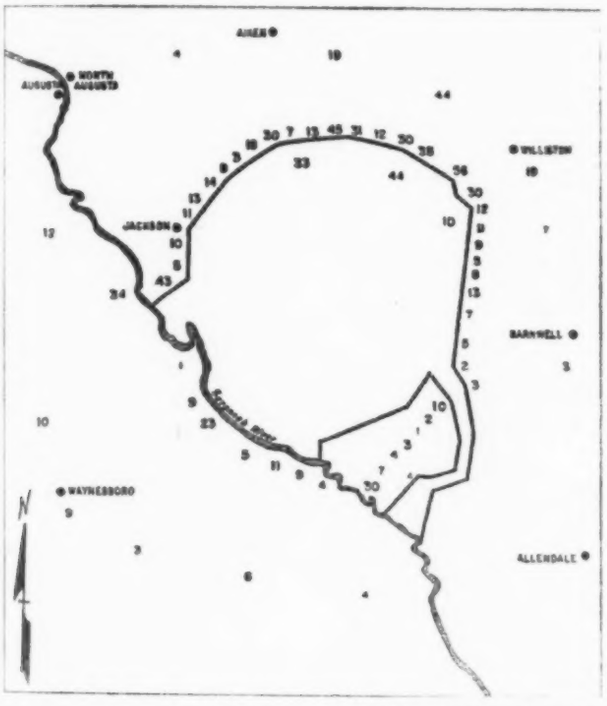

FIGURE 16.—IODINE-131 CONCENTRATIONS ($\mu\mu c/m^3$) IN BERMUDA GRASS IN THE VICINITY OF SAVANNAH RIVER PLANT, JUNE 5, 1961

Gamma Radiation Levels

Environmental gamma radiation dose rates are measured continuously at each of the 15 air monitoring stations shown in figure 12. The average dose rates at the perimeter were 0.32 and 0.29 mr per 24 hours for first and second quarters respectively. The levels at 25 mile radius for the two quarters were essentially the same—0.31 and 0.36 mr per 24 hours. This is slightly less than the North American average for January 1961 (0.42 mr/24 hr) as determined by the PHS Radiation Surveillance Network. (Refer to *Radiological Health Data* Volume II, Number 6.)

Estimated Exposure From the I^{131} Release

External Dose: The maximum off-plant dose rate from external sources to the whole body or to the gonads due to the release was calculated to be 0.0023 mrem/week for a person who continuously remained at the northeast plant boundary 168 hours per week. The International Commission on Radiological Protection recommends a weekly limit of 3.2 mrem/week (base on 5 rem per 30 years) for population at large.

Internal Dose: Based on the average concentration of I^{131} in milk from 41 farms and dairies on June 5 and June 6, consumption of this milk may have resulted in a thyroid exposure of 23 mrem. This exposure integrated over a period of a year averages 0.5 mrem/week.

Contributions to the internal dose to man from inhaled air, drinking water or consumption of the other foods were less than 10 percent of the dose resulting from I^{131} in milk.

Announced Nuclear Detonations

Radiological Health Data, Volume II, Numbers 10, 11, and 12, and Volume III, Number 1, published the dates of the Union of Soviet Socialist Republics and the United States announced nuclear detonations through January 1, 1962. The following table gives information on the subsequent tests reported through February 1, 1962. Low yield range has been announced as meaning about a nominal (20 kiloton yield) ; low-intermediate to mean between a nominal and one megaton yield.

ANNOUNCED U.S. DETONATIONS

Test number	Location	Date	Size	Type of test
10	Nevada Test Site	January 9	Low yield	Underground
11	Nevada Test Site	January 18	Low yield	Underground
12	Nevada Test Site	January 30	Low yield	Underground

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